National Imagery Transmission Format Standard

TUTORIAL

Prepared by:
Joint Interoperability Test Command

Updated:
02 March 2004

TUTORIAL OUTLINE

A. BACKGROUND
B. FORMAT OVERVIEW
C. DIGITAL IMAGERY CONCEPTS (Overview)
D. FORMAT DETAILS
E. COMPRESSION
F. ANNOTATION
G. EXTENSIONS
H. PRODUCTS
I. WRAP-UP

BACKGROUND

- **NITFS HISTORY**
- **STANDARDS COMMITTEES**
- **RELATED STANDARDS EFFORTS**
- **NITFS EVOLUTION STRATEGY**
- **NITFS OBJECTIVES**
- **NITFS OPERATIONAL CONCEPT**
- **NITFS SUITE OF STANDARDS**
- **NITFS TEST AND EVALUATION PROGRAM**

NITFS HISTORY

- 1989 - NITF 1.1 published and disseminated for general use (March)
- 1990 - NITF Certification Test Facility (CTE) established
- 1991 - NITF began conversion to Department of Defense Standards,
  name changes to NITFS
- 1993 - Completed development and validation of NITF 2.0
- 1994 - Certification testing of NITF 2.0 systems & software
- 1995 - Began development of: MIL-STD-2500B NITF 2.1,
  ISO 12087-5 BIIF, and STANAG 4545 NSIF 1.0
- 1998 - ISO 12087-5 BIIF approved as an international

STANDARDS COMMITTEES

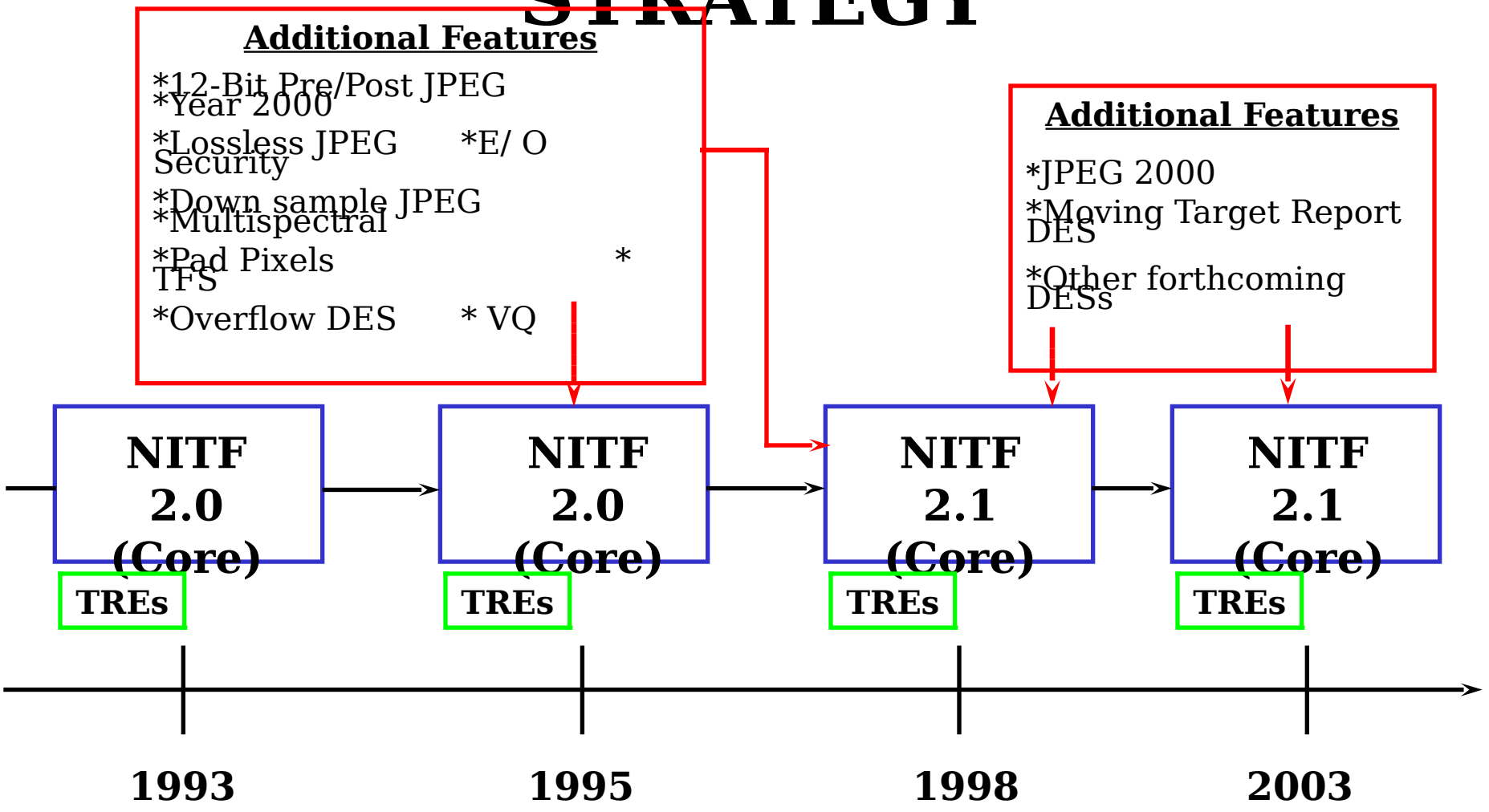
- **ISO/IEC JTC 1 – Information Technology**
  - SC 24 – Computer Graphics and Image Processing
    - WG 7 – Image Processing and Interchange
- **American National Standards Institute (ANSI)**
  - InterNational Committee for Information Technology Standards (INCITS)
    - **H3 – Computer Graphics and Image Processing**
- **NATO Air Force Armaments Group**
  - **Air Group IV – Reconnaissance & Surveillance**
    - ISR STANAG Custodial/Technical Support Teams
- **Defense Standardization Program (DSP)**
  - NITFS Technical Board (NTB)
    - Format Working Group (FWG)
    - Bandwidth Compression Working Group (BWCWG)
    - Additional adhoc Working Groups as needed

NGA/T/GIS has the responsibility for the NITFS
(NGA Strategic Transformation Office/Geospatial Intelligence Standards)

RELATED STANDARDS EFFORTS

- **ISO/IEC 12087-5 Basic Image Interchange Format (BIIF)**
- **STANAG 4545 NATO Secondary Imagery Format (NSIF)**
- **Digital Geographic Information Exchange Standard (DIGEST)**
- **Open Skies Treaty (BIIF Profile)**
- **Spatial Data Transfer Standard (SDTS), Part 5 (Raster Profile)**
- **Commercial Satellite Data Product Specifications**
- **Airborne Data Product Specifications**
- **UAV/Reconnaissance Data Product Specifications**
- **Implementation Practices of the NITFS (IPON)**

NITFS EVOLUTION STRATEGY



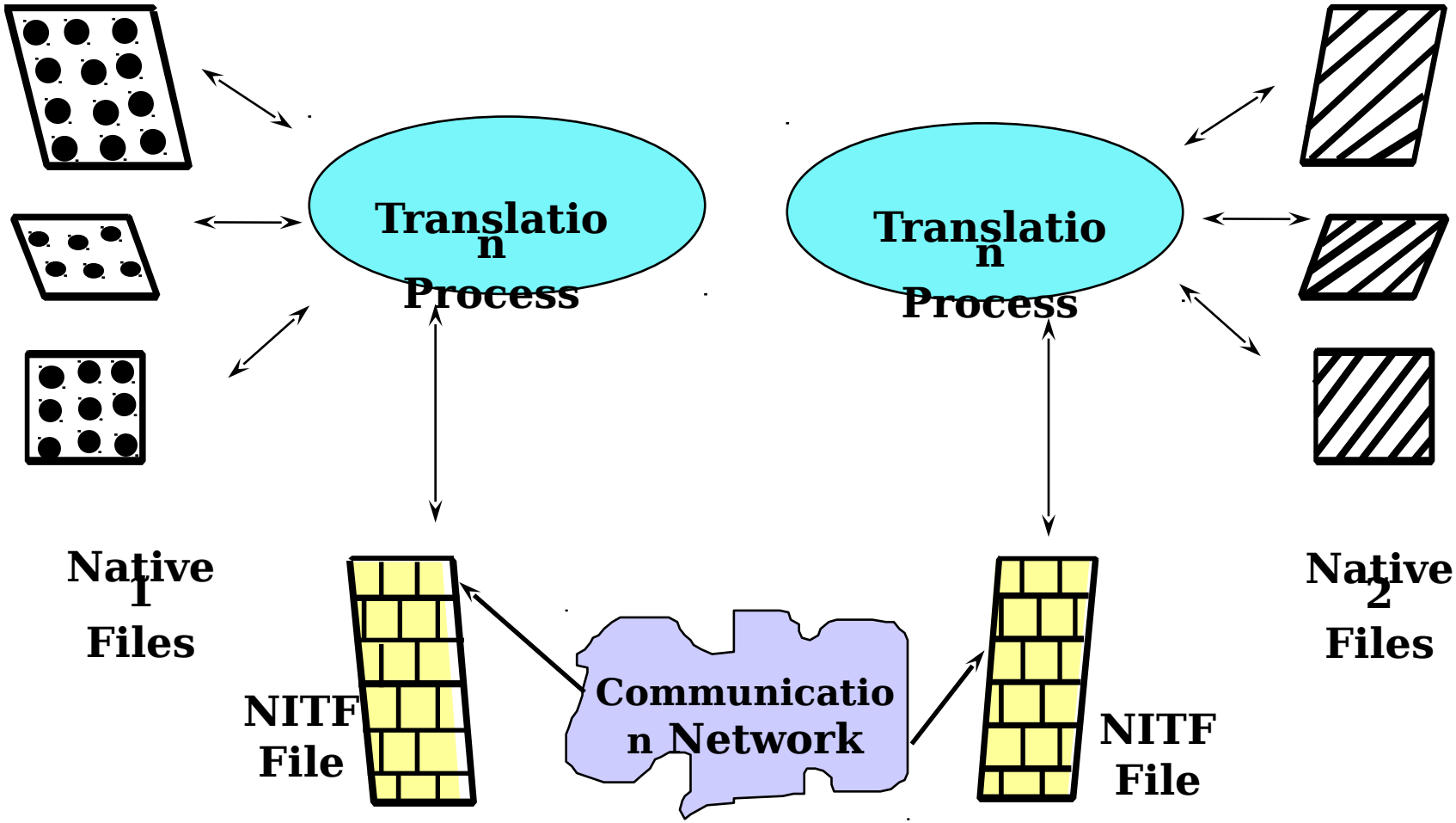
NITFS OBJECTIVES

- To provide a means for diverse systems to share imagery & associated data.
- To enable systems to exchange comprehensive information in a single file to users with diverse needs & capabilities.
- To enable users to select only data items that correspond with their needs & capabilities.
- To minimize the cost & schedule required to achieve the capability to share imagery & associated data.

NITFS OPERATIONAL CONCEPT

- Data interchange between systems is potentially enabled by a cross-translation process.
- Systems only need to comply with one (vice many) external formats.
- Systems will have the capability to translate internal representation for data to and from the NITF file format.
- Systems will have the capability to exchange with one or more recipients using: Tactical Communication Protocol (TACO2), TCP/ IP, LAN/WAN, Command WANs, and/or Media (e.g., tape, CD, etc.).

NATIVE MODE TO NITF



NITF 2.0 CORE SUITE OF STANDARDS

- **MIL-STD-2500A** National Imagery Transmission Format (NITF) (Version 2.0) for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-2301** Computer Graphics Metafile for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-196** Bi-Level Image Compression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-197A** Adaptive Recursive Interpolative Differential Pulse Code Modulation (ARIDPCM) Image Compression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-198A** Joint Photographic Experts Group (JPEG) Image Compression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-199** Vector Quantization Decompression for the National Imagery Transmission Format Standard (NITFS).

NITF 2.1 CORE SUITE OF STANDARDS

- **MIL-STD-2500B** National Imagery Transmission Format (NITF) (Version 2.1) for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-2301A** Computer Graphics Metafile for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-196** Bi-Level Image Compression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-198A** Joint Photographic Experts Group (JPEG) Image Compression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-188-199** Vector Quantization Decompression for the National Imagery Transmission Format Standard (NITFS).
- **MIL-STD-2045-44500** Tactical Communications Protocol 2 (TACO2) for the National Imagery Transmission Format Standard (NITFS).

http://164.214.2.51/ntb/

ADDITIONAL NITFS KEY DOCUMENTS

- **N-0105/98** National Imagery Transmission Format Standard (NITFS) Standards Compliance and Interoperability Test and Evaluation Program Plan Version 1.0
- **N-0106/98** National Imagery Transmission Format Standard (NITFS) Bandwidth Compression Standards and Guidelines
- **STDI-0002** The Compendium of Controlled Extensions (CE) for the NITFS
- **ISO/IEC 12087-5** Basic Image Interchange Format (BIIF)
- **ISO BIIF Profile** NATO Secondary Imagery Format (NSIF) Version 1.0
- **ISO/IEC 15444 Part 1** JPEG 2000
- **ISO/IEC 15444 Part 4** JPEG 2000 Compliance Testing
- **JPEG 2000 Profile** Implementing JPEG 2000 in BIIF (NITF/NSIF)

http://164.214.2.5 1/mtb/

NITFS TEST PROGRAM

- **Test Director:**
  - Mr. Stephen Kerr
- **Sponsor:**
  - National Imagery and Mapping Agency (NIMA)
- **Objectives:**
  - Executive Agent for NIMA Imagery-related Testing
  - Standards Validation Testing
  - Standards Conformance Testing
  - Standards Based Interoperability Testing
- **Clients:**
  - DoD & Federal Agencies
  - NATO
  - Commercial Vendors

FREQUENTLY ASKED QUESTIONS….

Q. What exactly is NITFS Conformance Testing?

A. Conformance testing is a methodology that ensures all vendors and developers of imagery products interpret the NITF Standards in a uniform manner, thereby reducing the possibility of interoperability problems during system/product fielding.

Q. What does conformance testing reveal that can't be discovered by developmental or other testing performed in my own facility?

A. The NITFS Conformance Testing Program is universal. Vendors and developers around the world participate in the program. It would be impossible to expect every vendor or developer to interpret every specification in the same manner. Accordingly, the interpretations provided by NITFS CTE personnel provide the consistency and

MORE FREQUENTLY ASKED QUESTIONS…

Q. How much can I expect to pay for the JITC's NITFS Conformance Testing services?

A. Exact costs for the JITC's services are test dependent and are beyond the scope of this document; however, a reasonably accurate "rule of thumb" estimation can be based on a charge of approximately $1800 per test day.

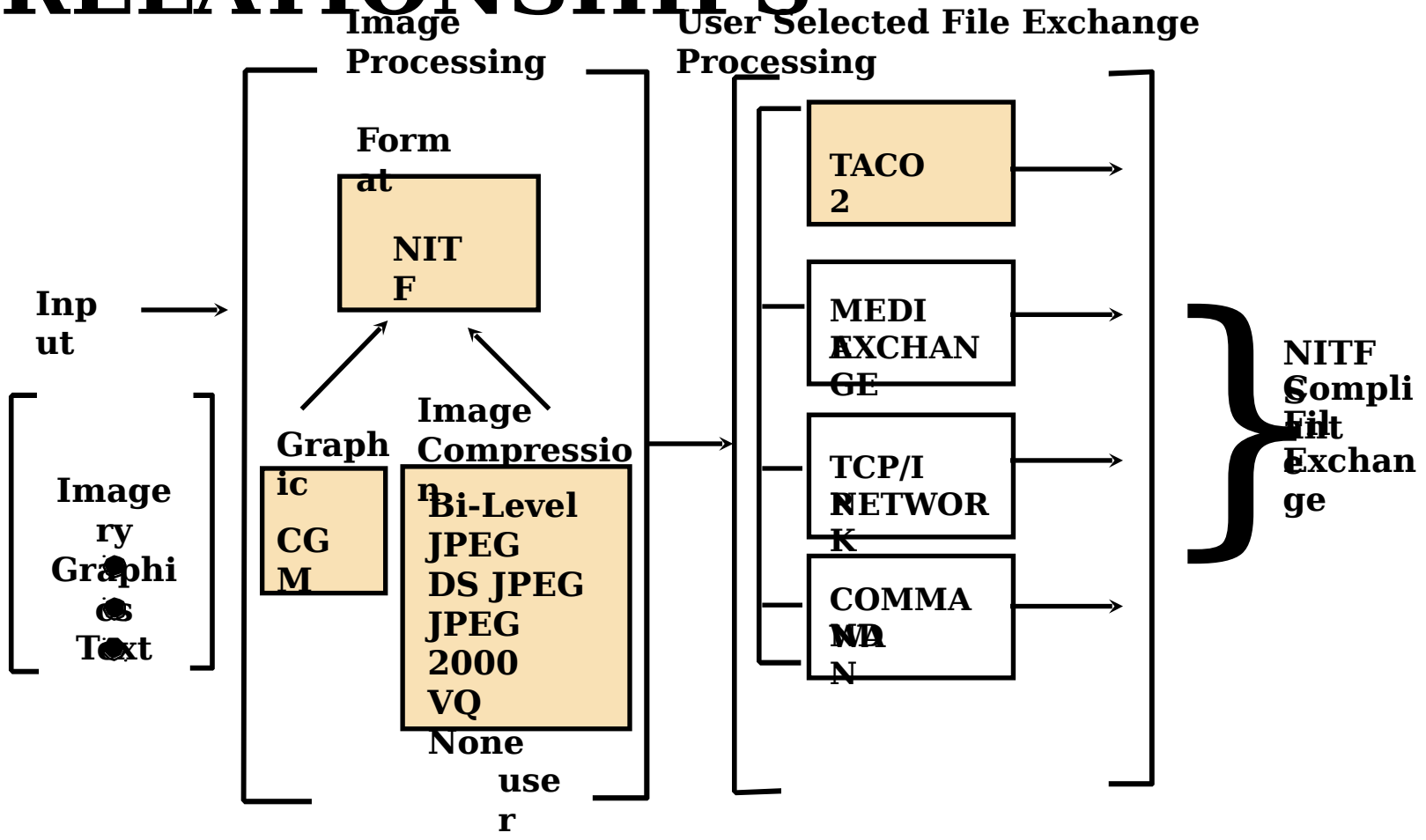
Q. How far in advance must I schedule a conformance test with the JITC?

A. Clients may call at anytime to discuss and schedule a test; however, the completed test forms and payment must be received prior to the test start date. Test periods are scheduled on a first-come, first-served basis, with exceptions and considerations available for bonafide emergencies or other unusual circumstances. Testing can usually be scheduled to begin within 6-10 weeks of a

FORMAT OVERVIEW

- **NITF FILE STRUCTURE**
  - **Fixed Fields**
  - **Extensible Fields**
  - **Extensible Segments**
- **VARIETY OF DATA SEGMENT TYPES**
  - **Images**
  - **Graphics (Symbols)**
  - **Labels (Phased out)**
  - **Text**
  - **Data Extension Segments**
  - **Reserved Extension Segments**

NITF COMPONENT RELATIONSHIPS



NITF FILE STRUCTURE

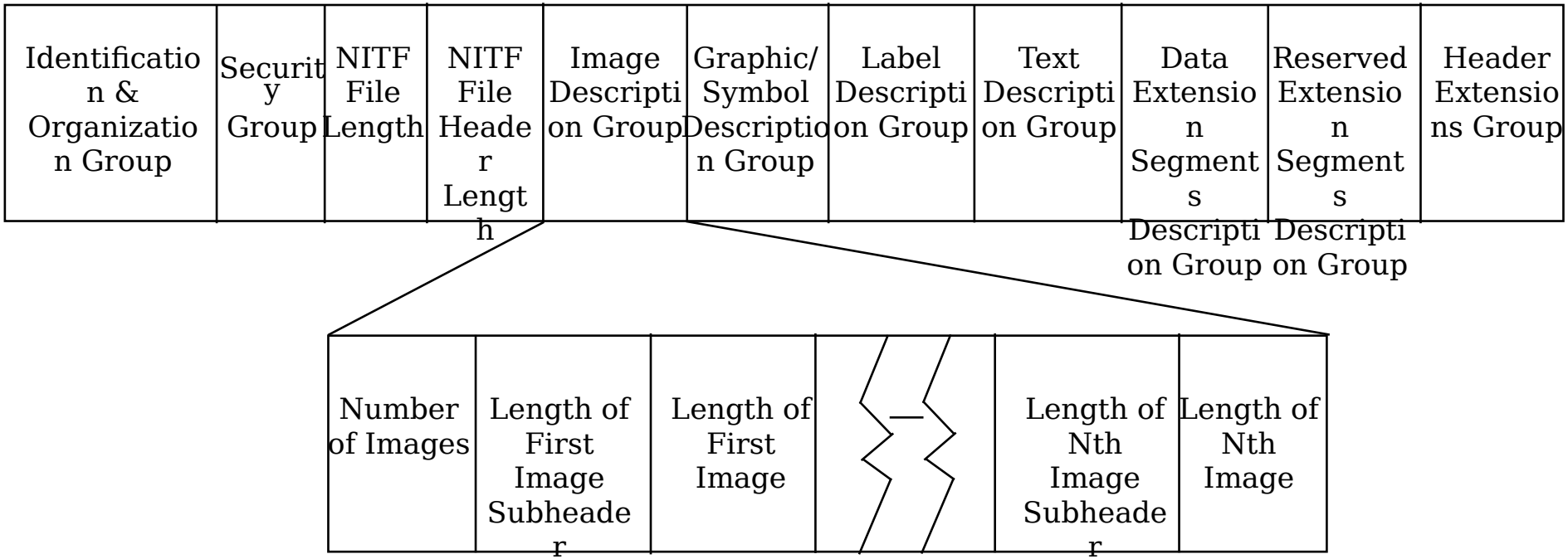
NITF 2.0 and NITF 1.1

NITF File Header	Image Segments	Symbol Segments	Label Segments	Text Segments	Data Extension Segments	Reserved Extension Segments

NITF

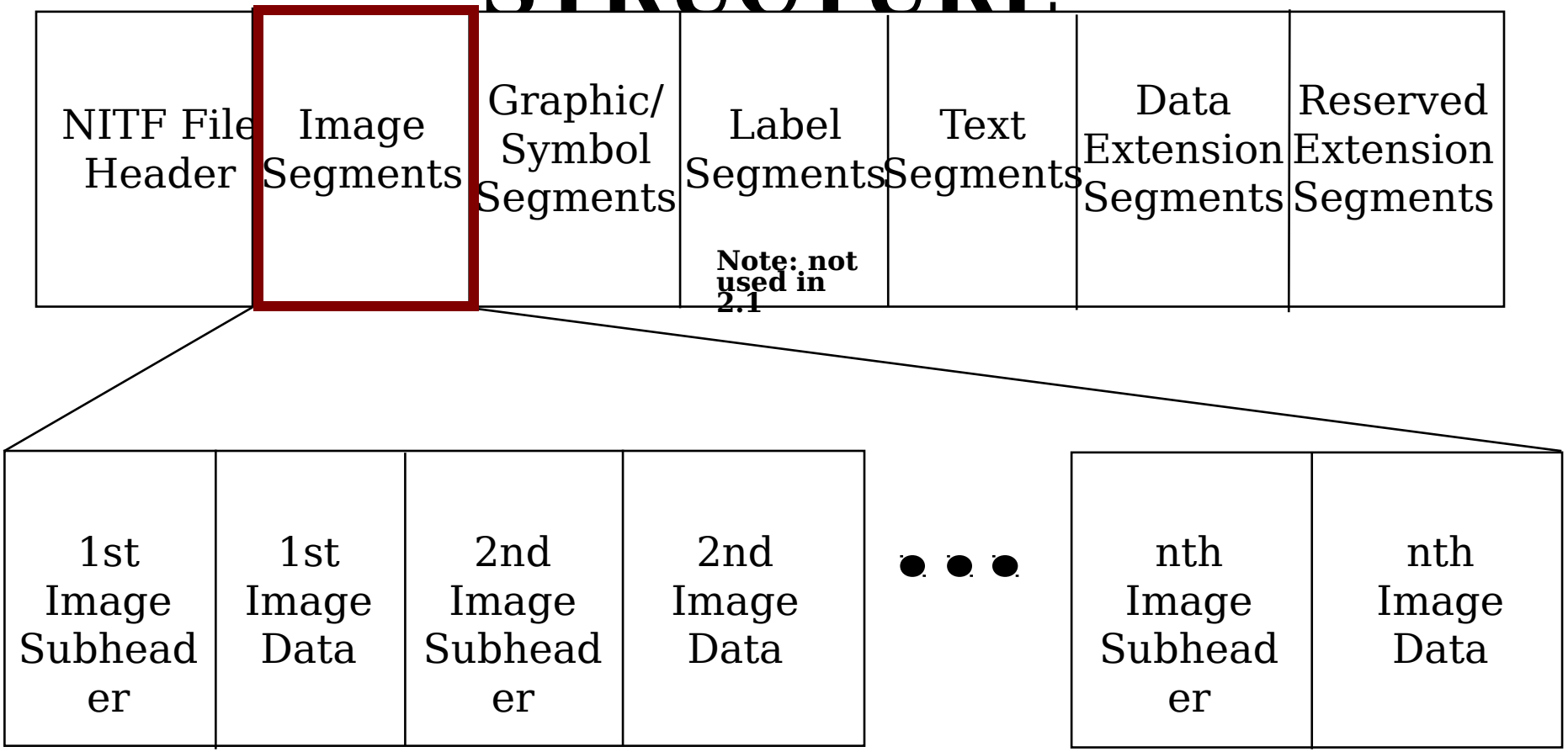
NITF File Header	Image Segments	Graphic Segments	Text Segments	Data Extension Segments	Reserved Extension Segments

NITF FILE HEADER STRUCTURE

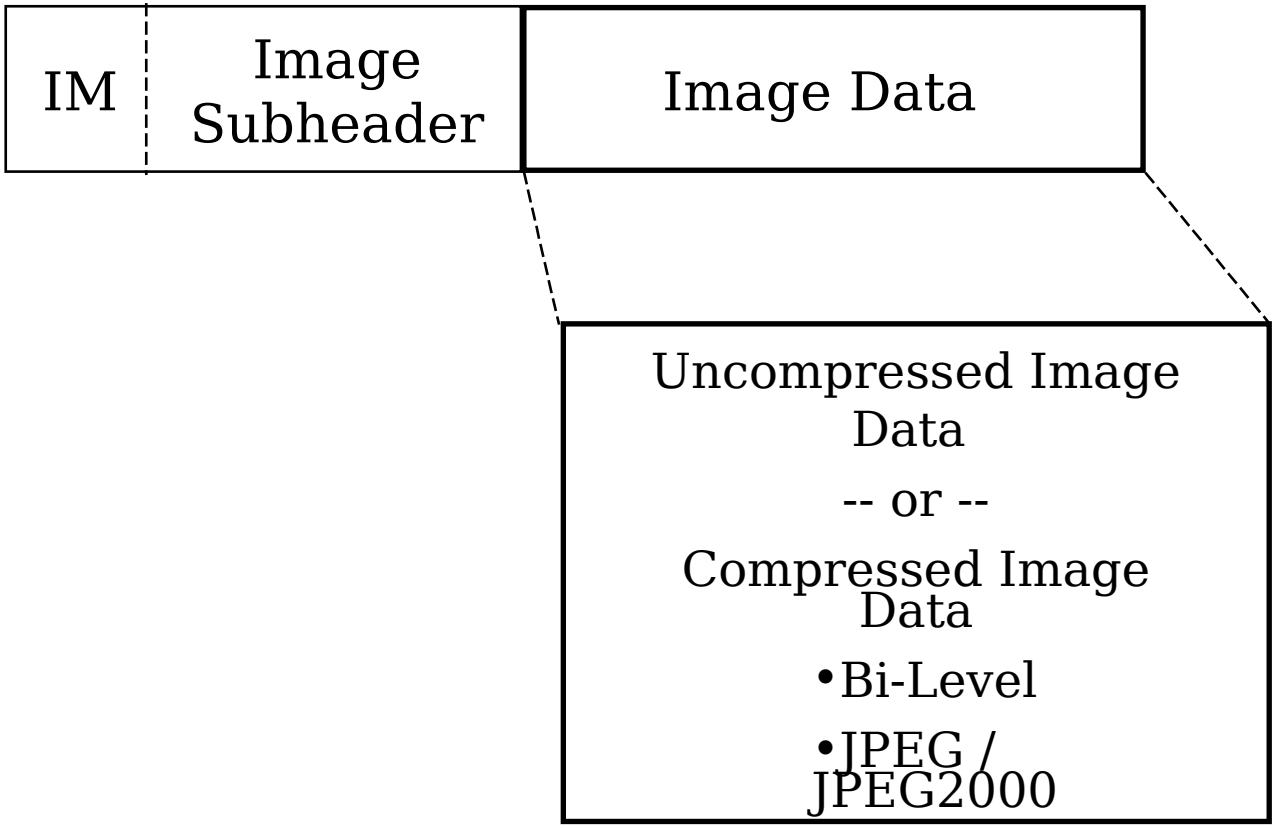


NOTE: Date/Time fields changed in NITF 2.1 for Y2K
Security Group fields changed in NITF 2.1 to comply with EO 12958

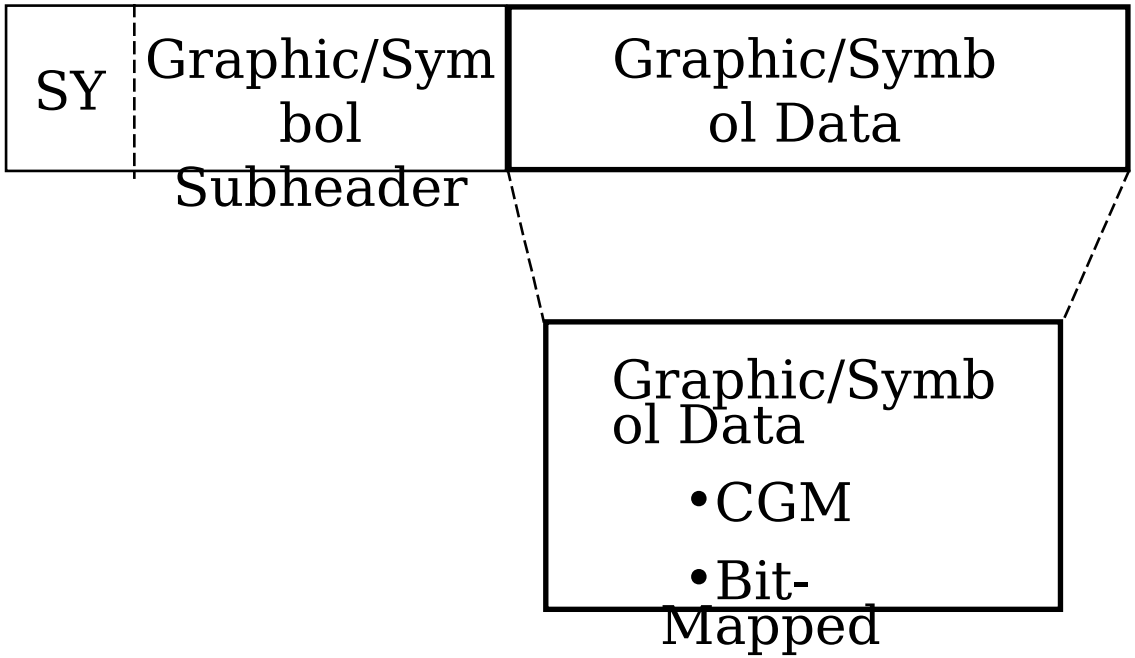
NITF IMAGE SEGMENT FILE STRUCTURE



NITF IMAGE SEGMENT FILE STRUCTURE (CONT'D)

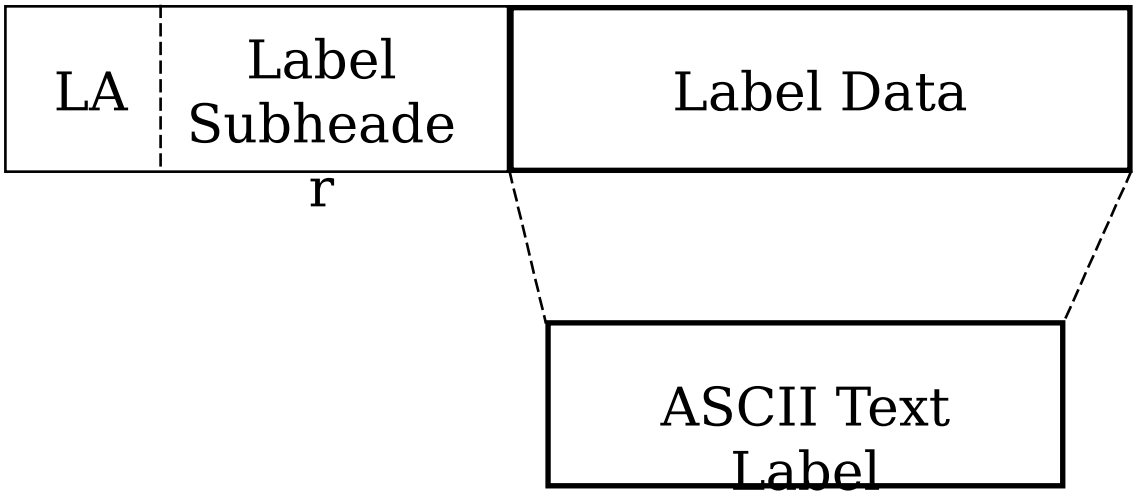


NITF SYMBOL SEGMENT FILE STRUCTURE



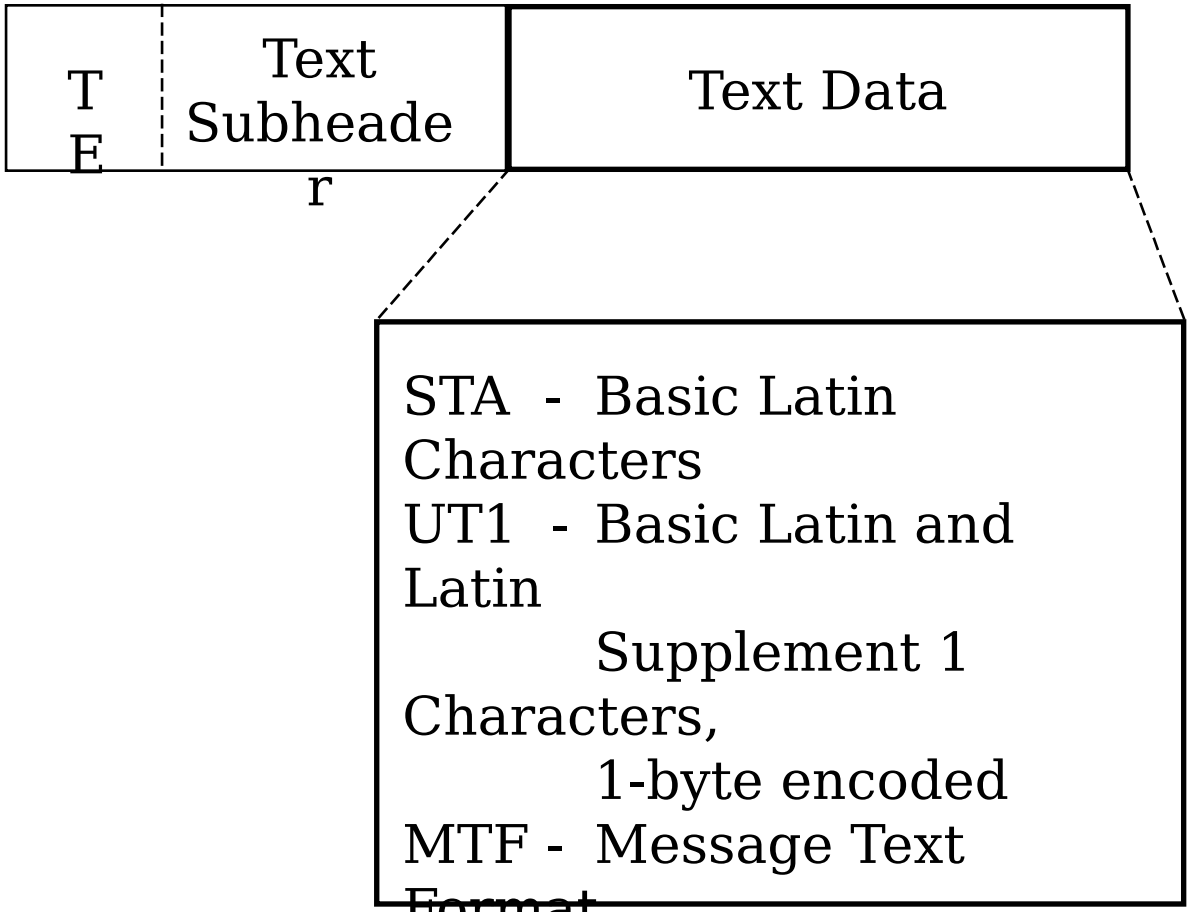
Note: Bit-Mapped symbols are not used in NITF 2.1

NITF LABEL SEGMENT FILE STRUCTURE

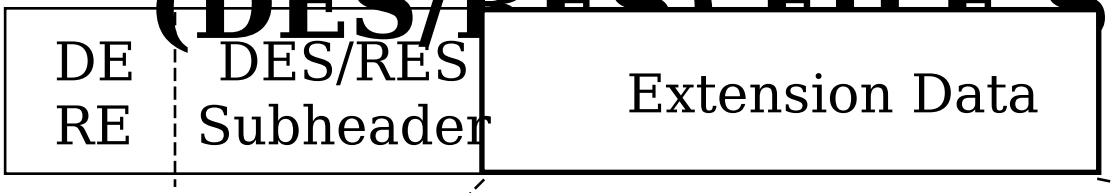


Note: Label Segments are not used in NITF 2.1

NITF TEXT SEGMENT FILE STRUCTURE



NITF DATA/RESERVED EXTENSION SEGMENT (DES/RES) FILE STRUCTURE



(NITF 2.0)

DES Data

- Registered Extensions
- Controlled Extensions

RES Data

- None Defined

(NITF 2.1)

DES Data

- TRE_ OVERFLOW
- STREAMING_FILE_HEADER
- Others are forthcoming

RES Data

- None Defined

DIGITAL IMAGERY CONCEPTS

NITFS Vocabulary:

- Rasters, Pixels, Etc.
- Blocking, Masking, and Interleaving
- Color Look-Up Tables
- Imagery Annotations
- Textual Adjuncts
- Common Coordinate System
- Display and Attachment Levels
- Support Data Extensions

NITFS VOCABULARY

- **RASTER**
- **PIXELS**
- **BLOCK**
- **PAD PIXELS**
- **IMODE**
- **MASKED BLOCKS**
- **BANDS**
- **LUT**

Raster: Images defined as a set of pixels or dot values in row (line) and column (sample) format. A two-dimensional array of pixel values.

Pixel: The atomic element of an image having a discreet value. Although a pixel value represents a minute area of an image, the generic use of the term does not specify the exact shape or symmetry of the area (circle, oval, square, rectangle, other) represented by the value. An acronym for a Picture Element.

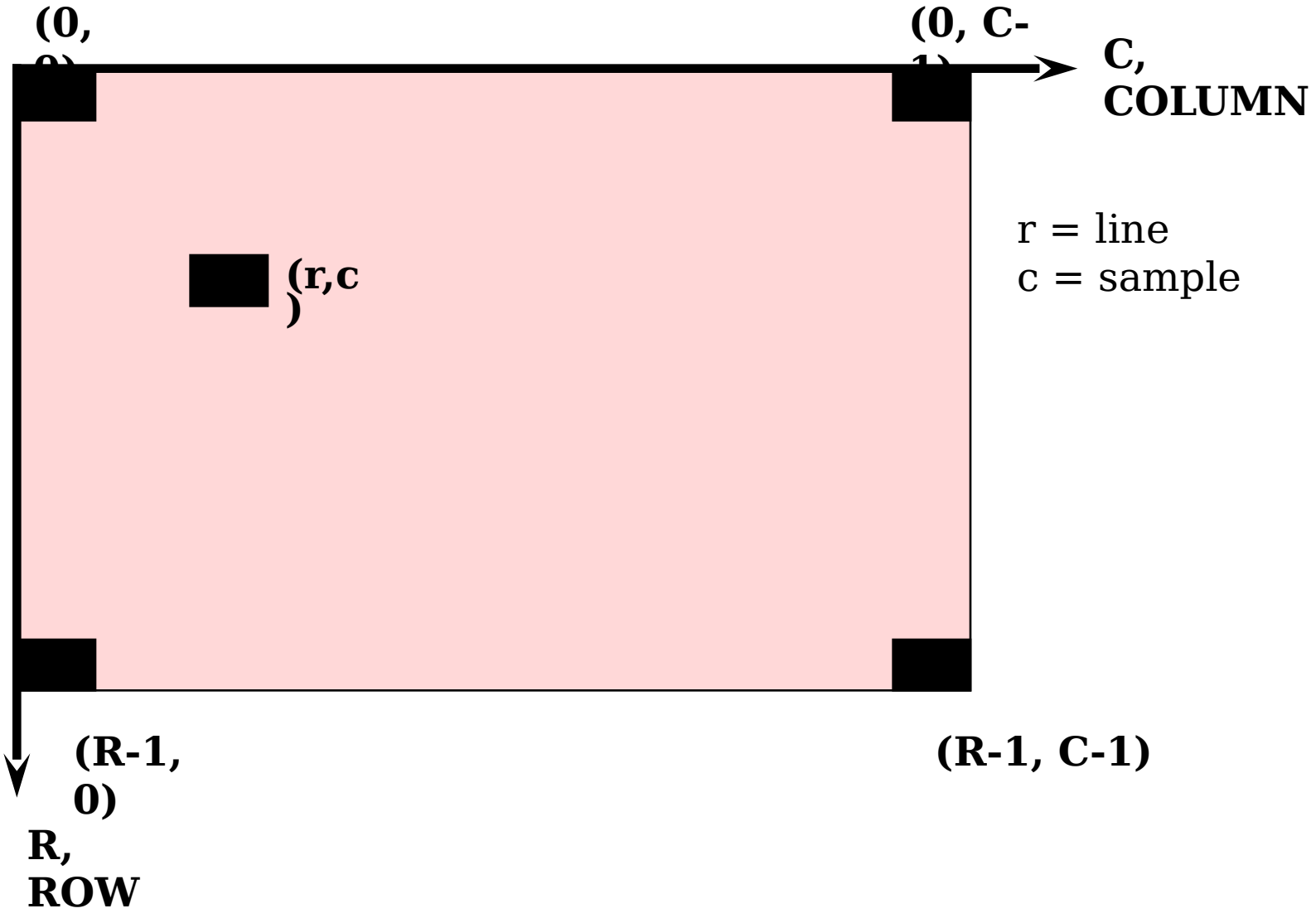
Block: A rectangular array of pixels. An image consists of the union of one or more non-overlapping blocks. (Synonymous with tile).

Pad Pixels: 1) A fill pixel given a specific identification value within an image block. Pad pixels are included to ensure that each block is filled with contiguous pixel values, but should be interpreted as having no meaning.
2) Transparent Pixel is a specified pad pixel value which must be interpreted to not obscure any underlying pixel

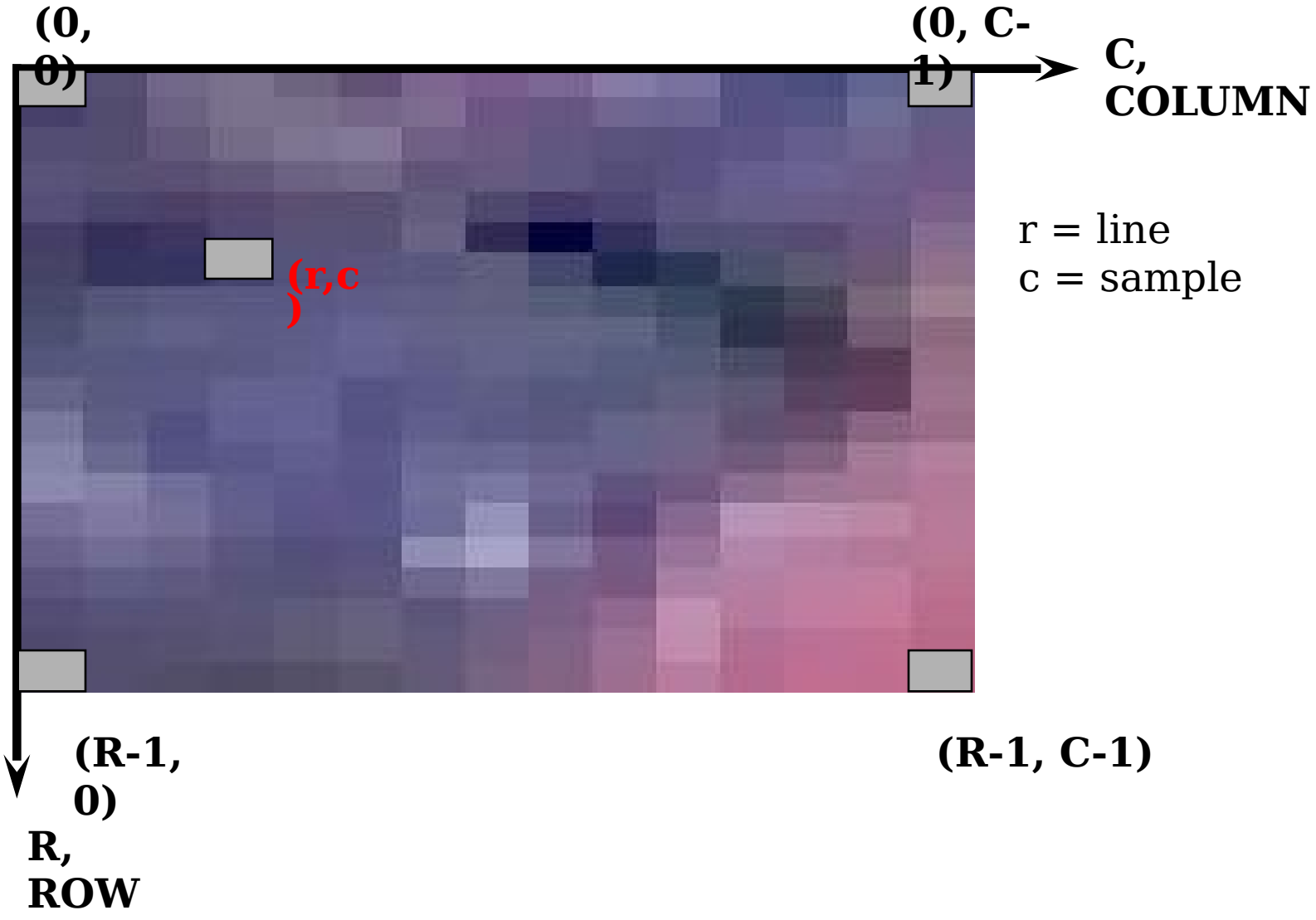
Masked Blocks: A structure which identifies the blocks in a blocked (tiled) image which contain no valid data, and which are not transmitted or recorded. The structure allows the receiver to recognize the offset for each recorded/transmitted block. For example, a 2x2 blocked image which contained no valid data in the second block (block 1) would be recorded in the order: block 0, block 2, block 3. The blocked image mask would identify block 1 as a non-recorded/non-transmitted block, and would allow the receiving application to construct the image in the correct order.

Band: One of the two-dimensional (row/column) pixel value arrays that comprise an image. In the case of gray scale, bi-level, or 8-bit color images, the representation is a single two-dimensional array; in the case of 24-bit true color images (8 bits for each of three color elements), the representation is three two-dimensional array of pixel values.

RASTER/PIXELS



RASTER/PIXELS



PIXEL/DATA VALUE TYPES

Bi-Level
- One-bit value
- Represents two colors or shades of gray

Integer
- N-bits value
- Represents 2^N colors or shades of gray
- For N = 8, 256 shades of gray
- For N = 12, 4096 shades of gray

Signed Integer
- N-bits value
- Positive and negative values (e.g., Elevation Postings)

Real
- IEEE 32/64-bit value
- Floating Point data representation

Complex
- IEEE 64-bit value
- 32-bit real value

BANDS

Single Band

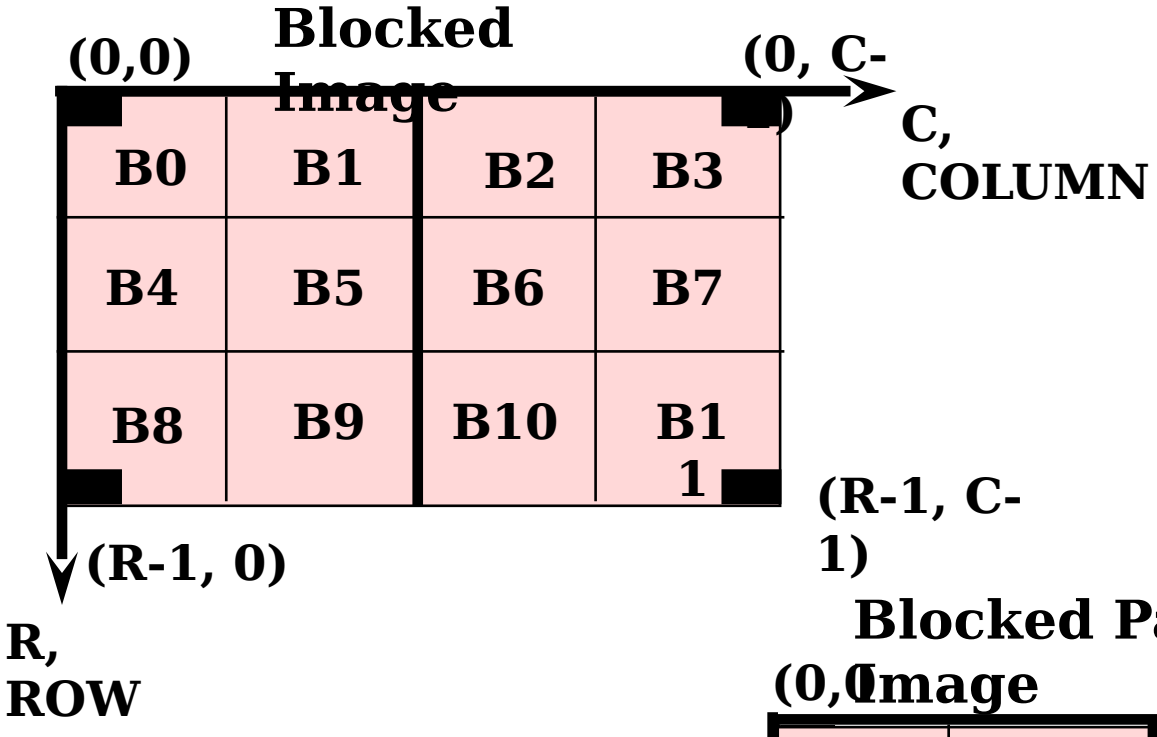
One pixel value per raster array location. (e.g., one 8-bit integer allows 256 shades of gray)

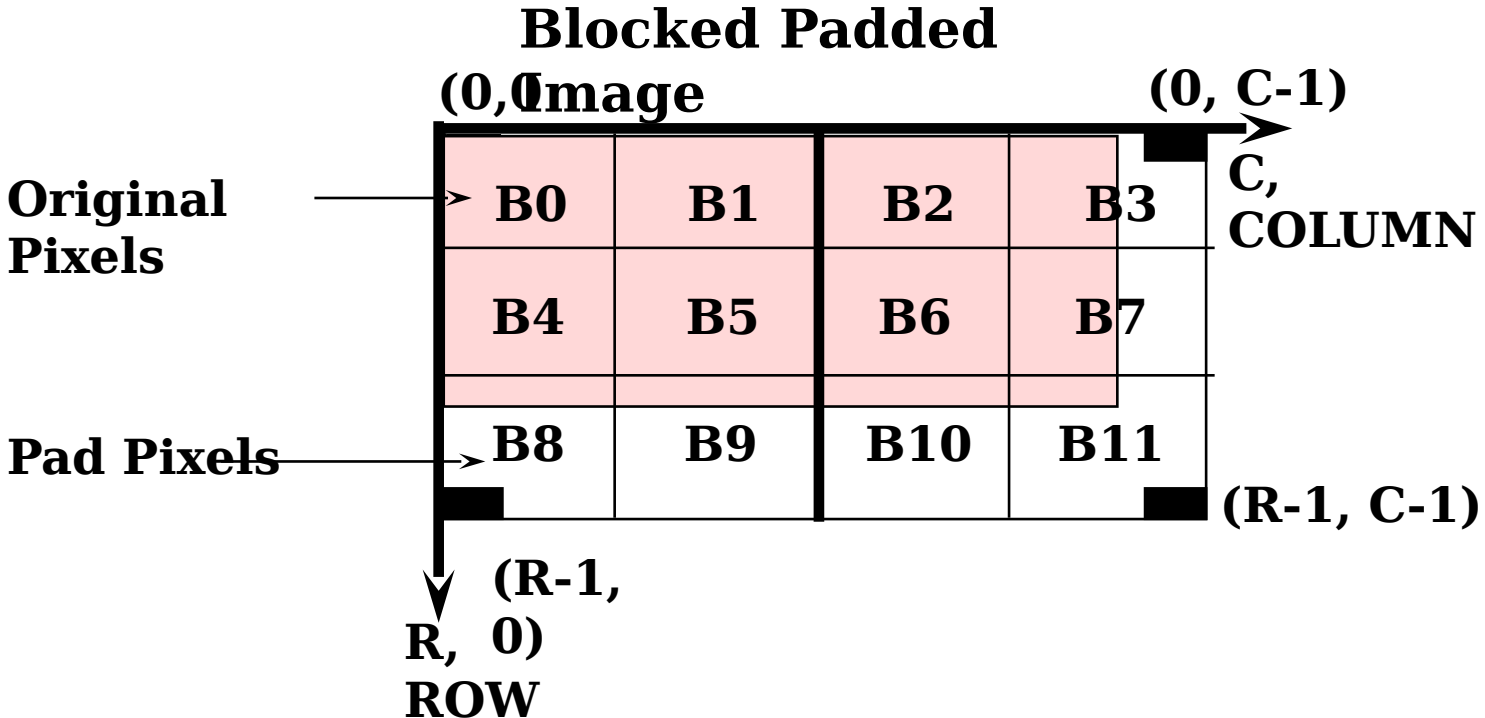
Multiple Band

N pixel values per raster array location.
Examples:

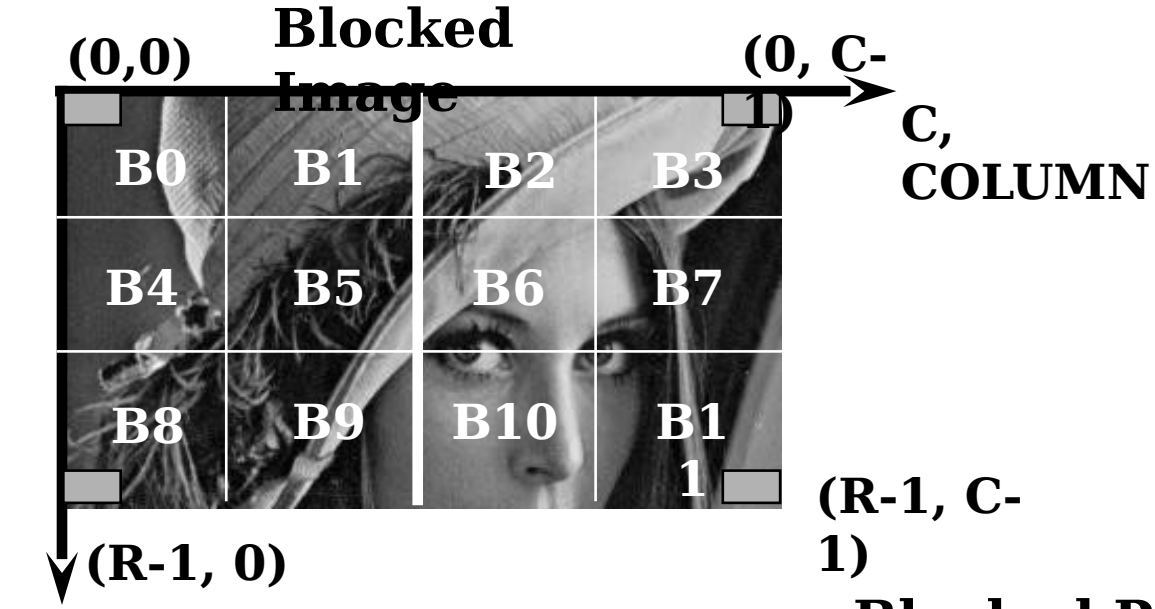
- RGB Three 8-bit integer values per pixel
- YCbCr Three 8-bit integer values per pixel
- Multi (e.g., seven 8-bit integer values per pixel)
- Multi (e.g., 256 32-bit real values per

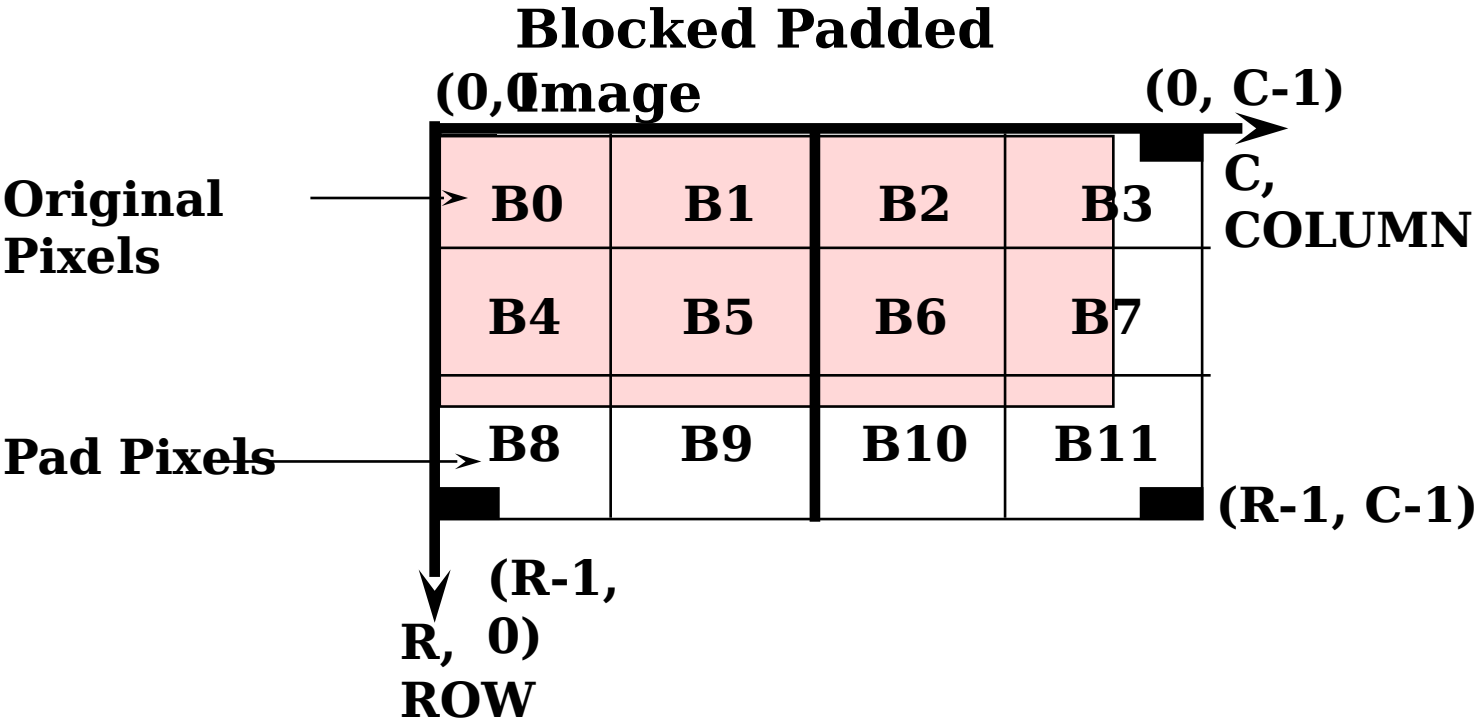
BLOCKING


Blocked Image
(0,0)
(0, C-1)
C, COLUMN
B0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
(R-1, C-1)
(R-1, 0)
R, ROW

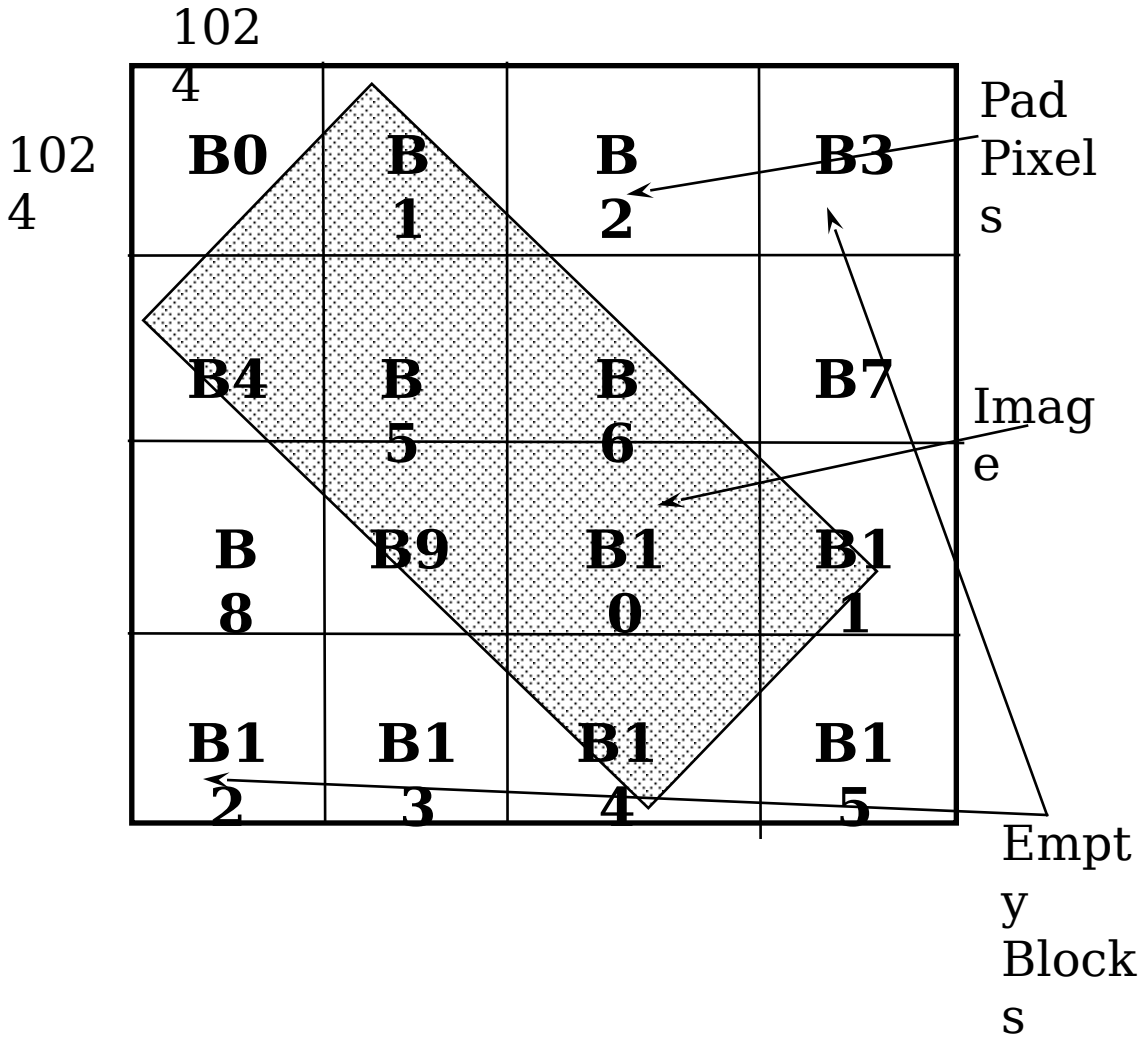

Blocked Padded Image
(0,0)
(0, C-1)
C, COLUMN
Original Pixels
Pad Pixels
B0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
(R-1, C-1)
(R-1, 0)
R, ROW

BLOCKING


Blocked Image
(0,0)
(0, C-1)
C, COLUMN
B0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
(R-1, C-1)
(R-1, 0)
R, ROW

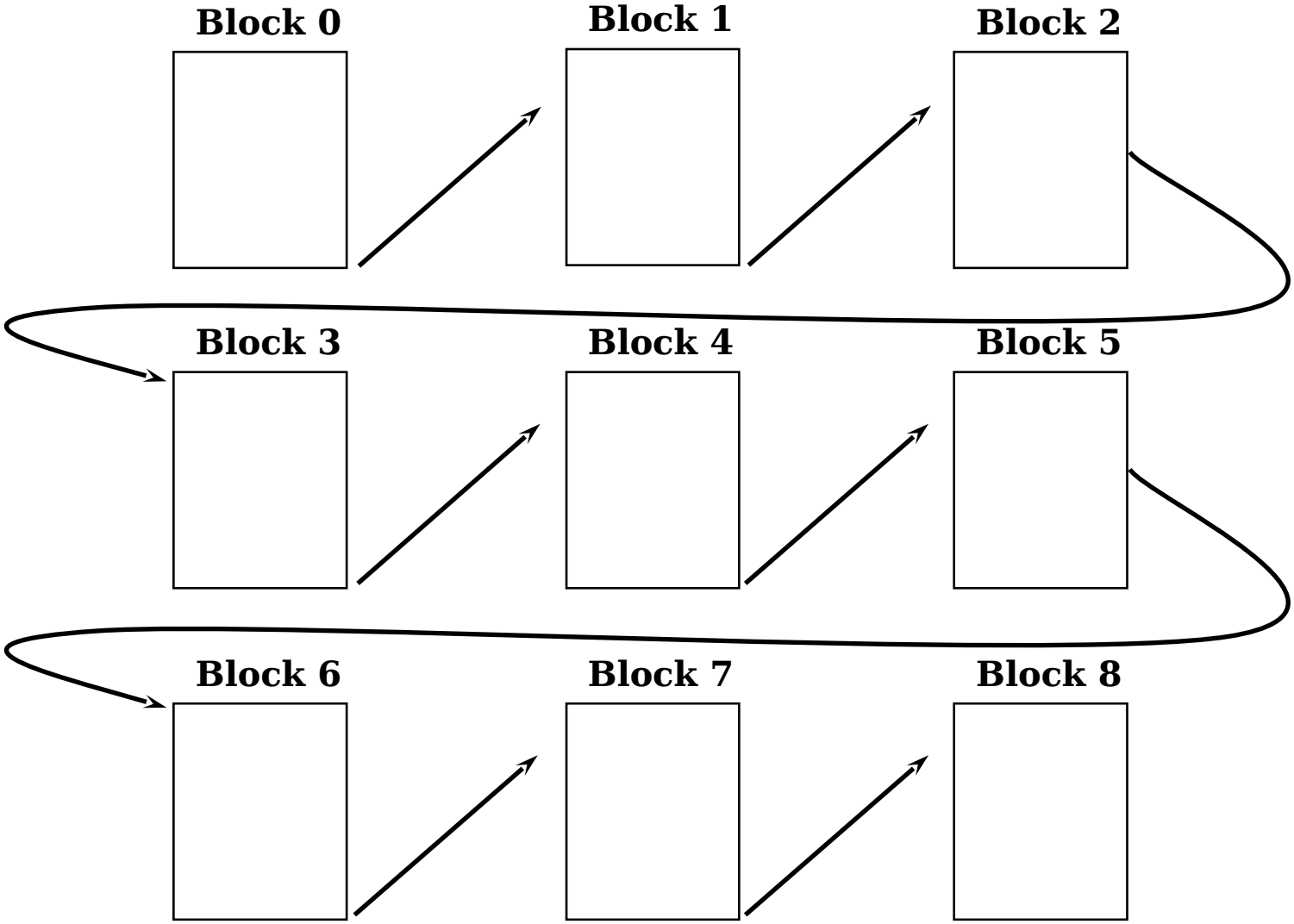

Blocked Padded Image
(0,0)
(0, C-1)
C, COLUMN
Original Pixels
Pad Pixels
B0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
(R-1, C-1)
(R-1, 0)
R, ROW

BLOCKED PADDED IMAGE WITH EMPTY BLOCKS



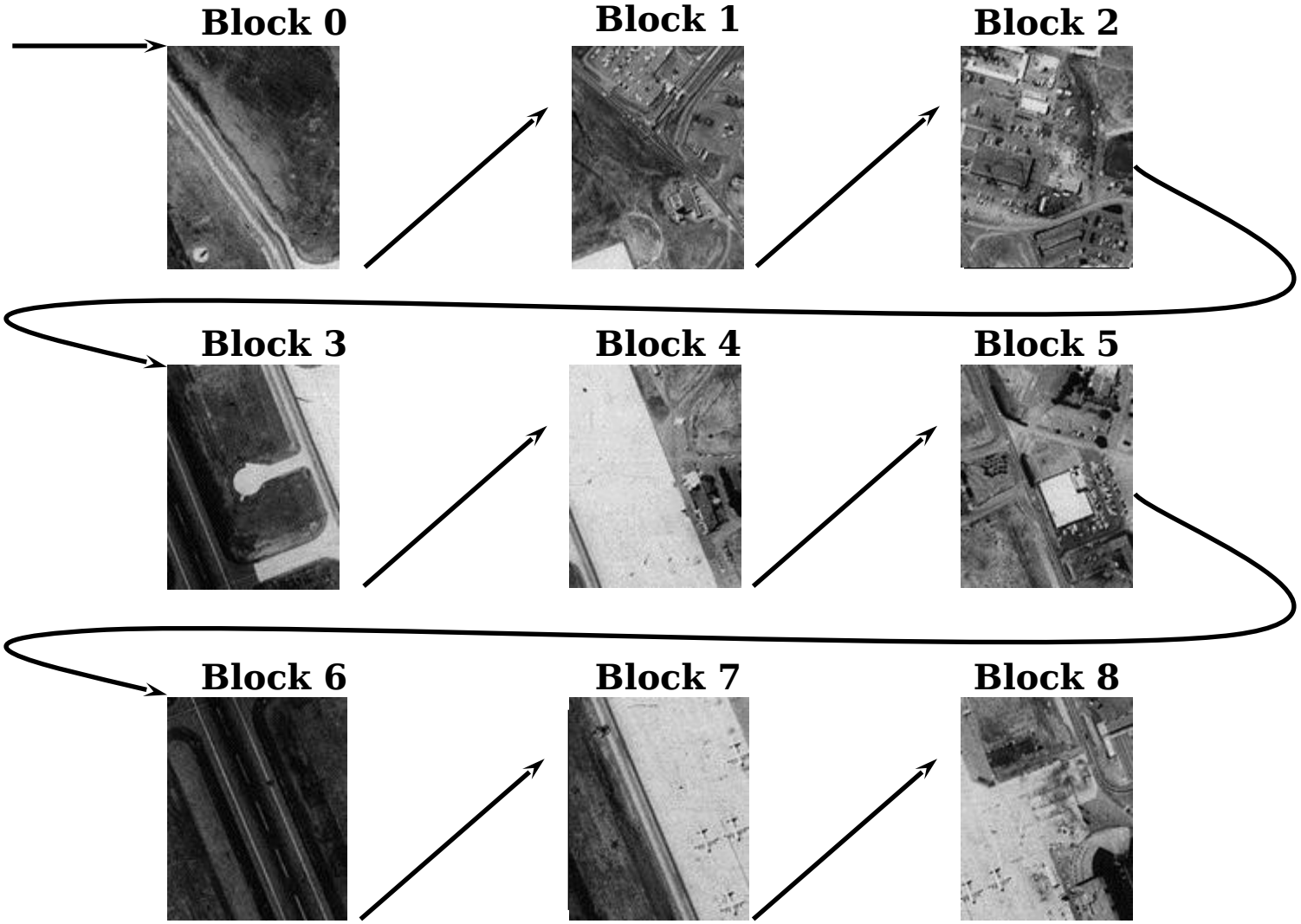

```
 0 - 0X00000000
 1 - 0X00100000
 2 - 0X00200000
 3 - 0XFFFFFFFF
 4 - 0X00300000
 5 - 0X00400000
 6 - 0X00500000
 7 - 0XFFFFFFFF
 8 - 0X00600000
```

IMODE = B, BAND INTERLEAVED BY BLOCK MONOCHROME CASE

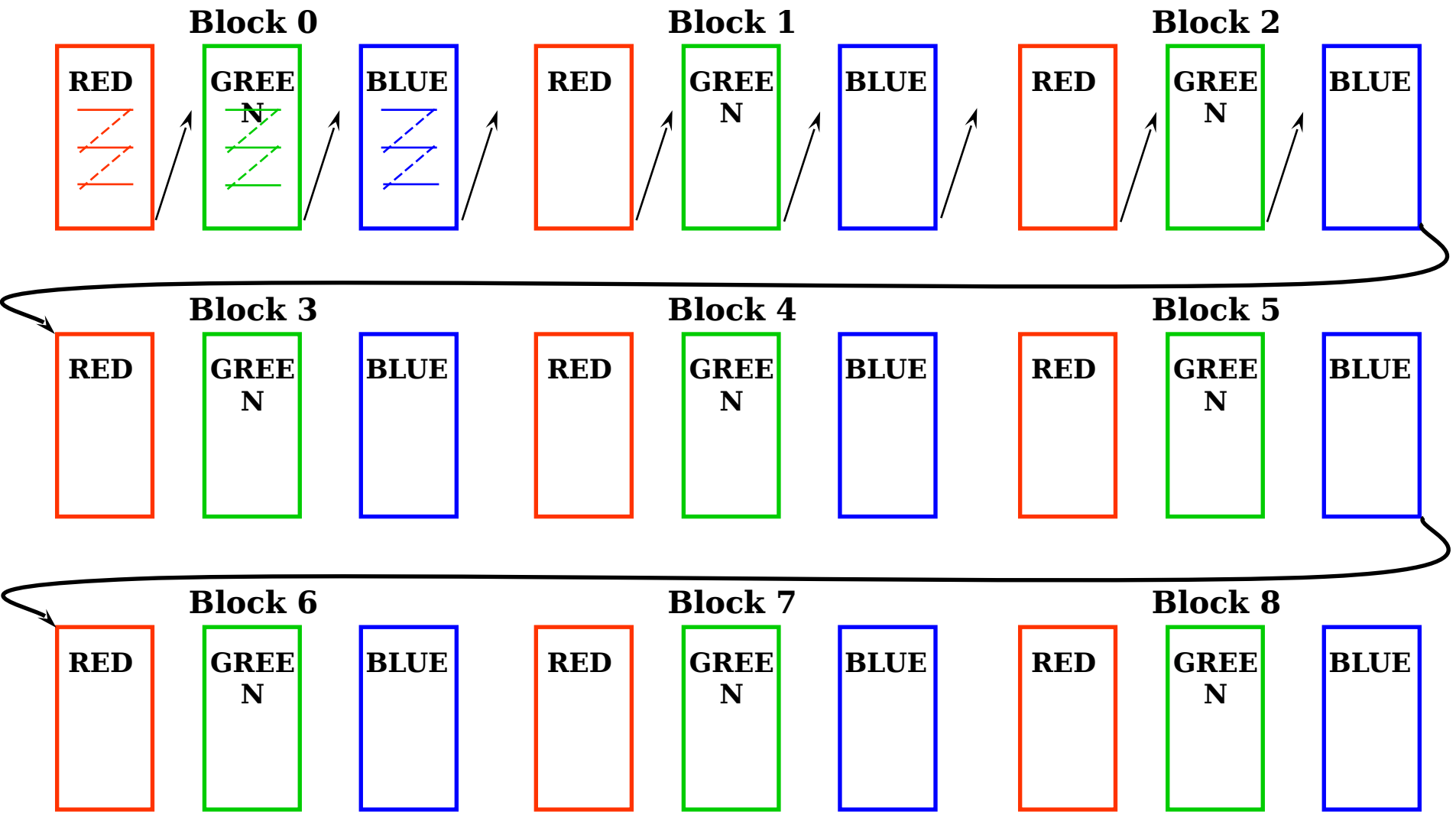


IMODE = B, BAND INTERLEAVED BY BLOCK MONOCHROME CASE

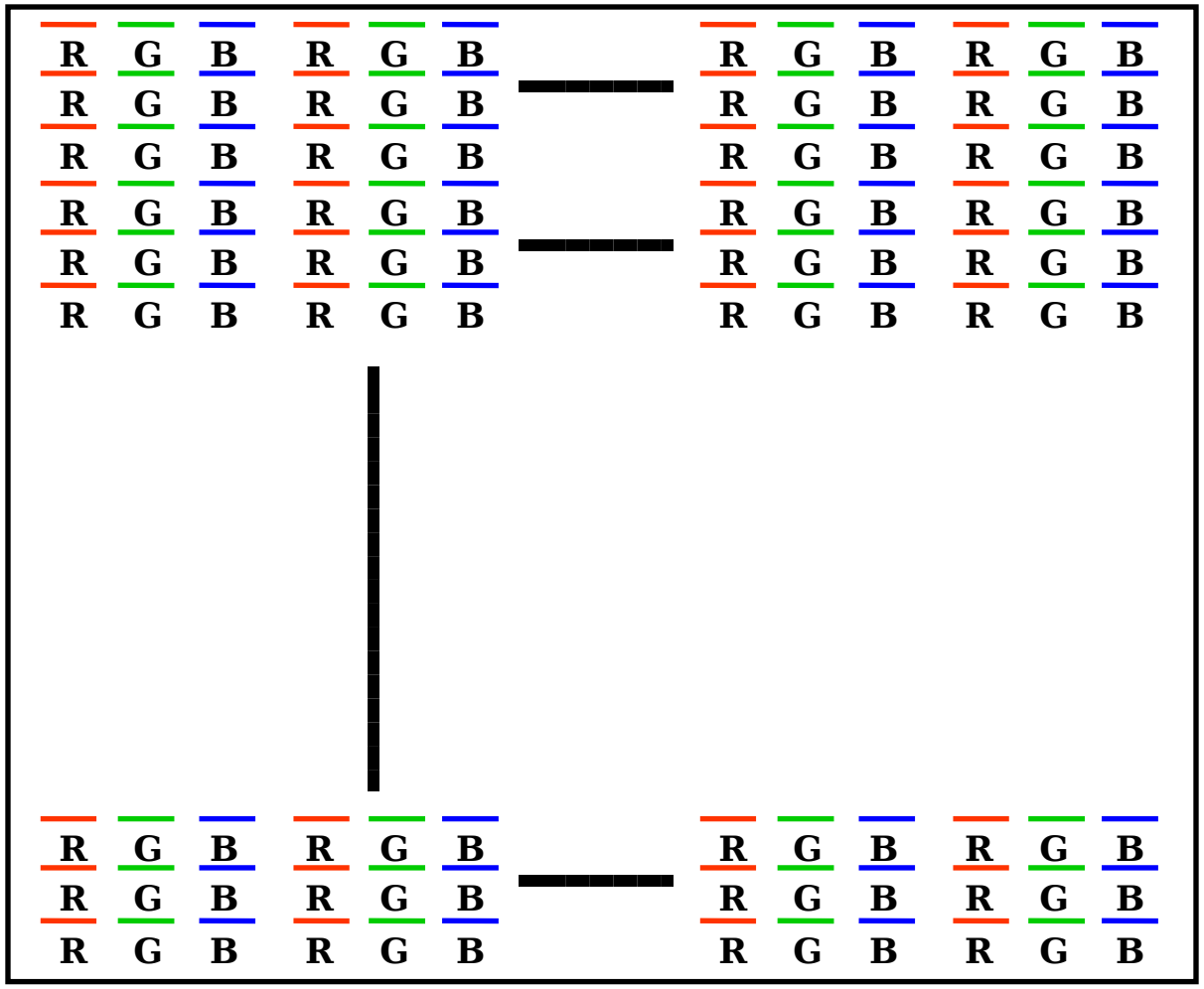
IMODE = B, BAND INTERLEAVED BY BLOCK MONOCHROME CASE



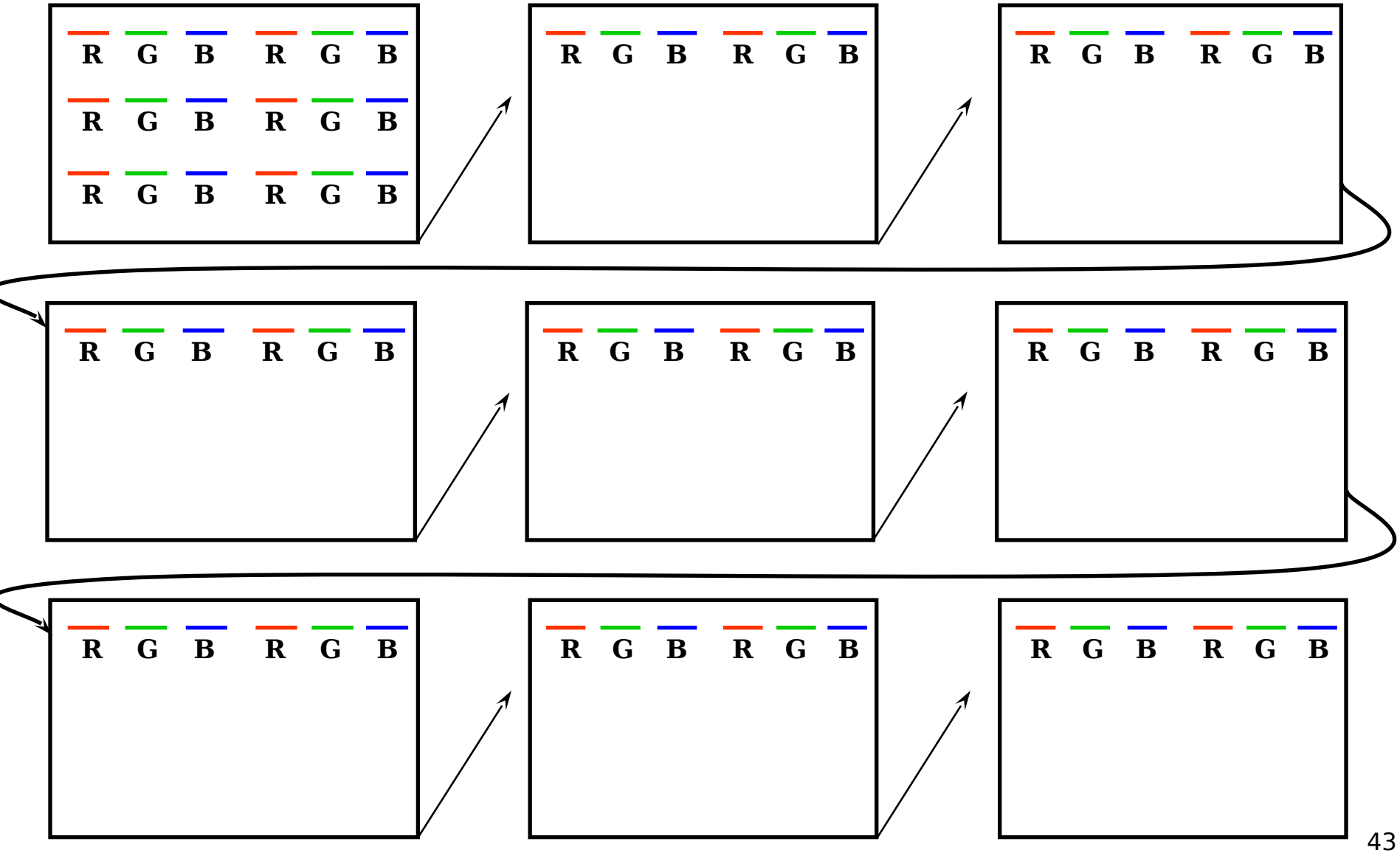
IMODE = B, BAND INTERLEAVED BY BLOCK THREE BAND COLOR CASE



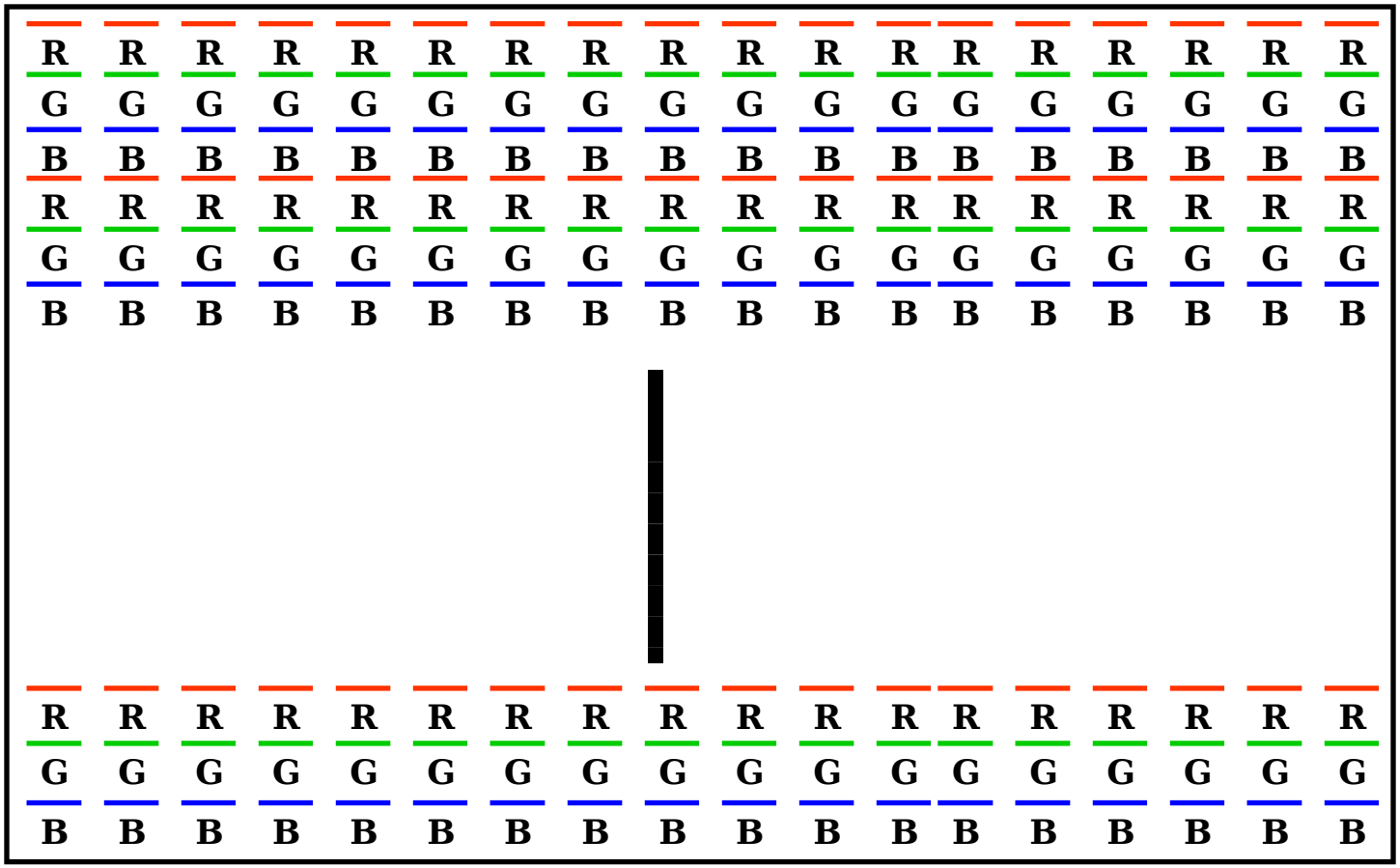
IMODE = P, BAND INTERLEAVED BY PIXEL THREE BAND COLOR CASE



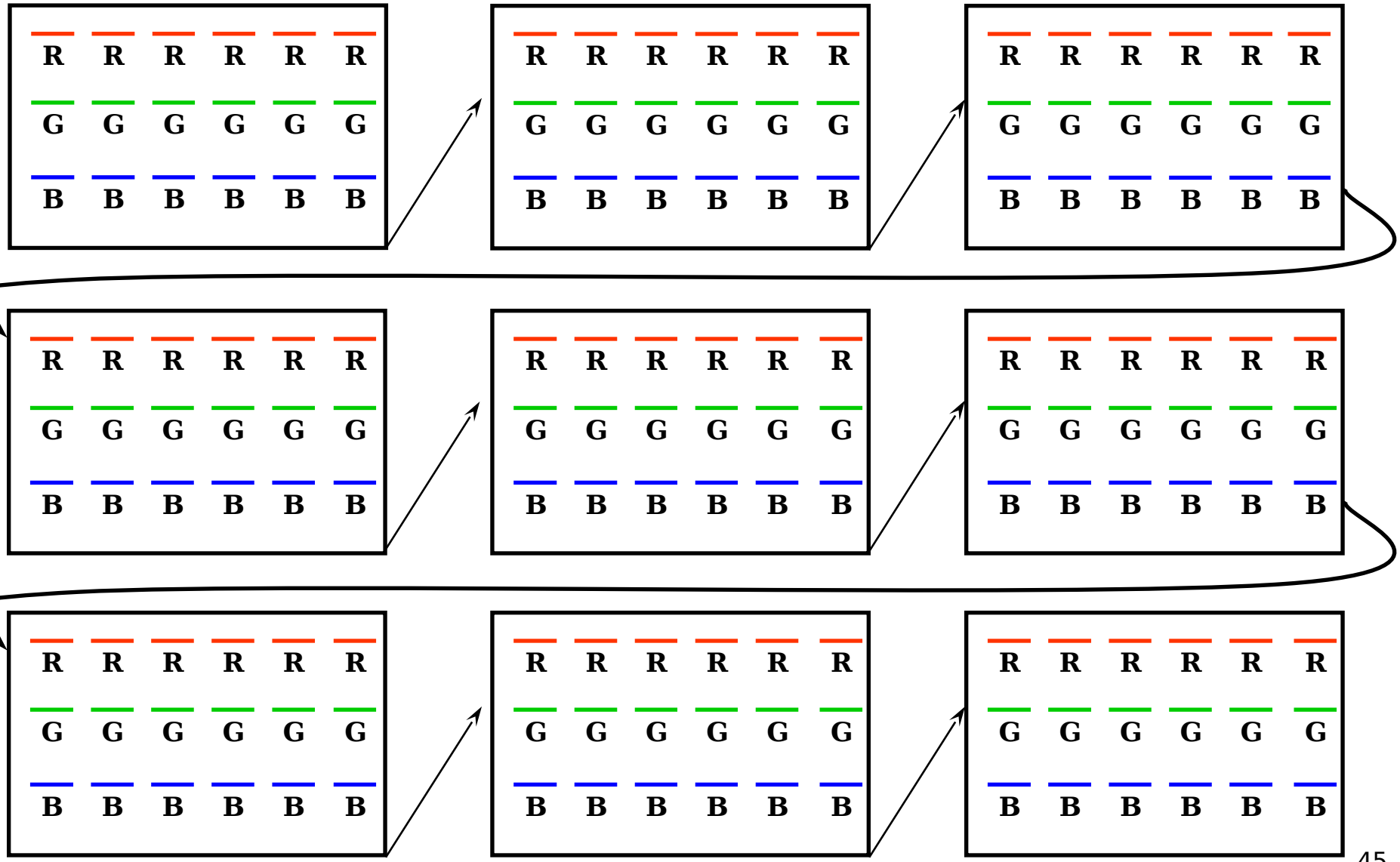
IMODE = P, BAND INTERLEAVED BY PIXEL THREE BAND COLOR CASE



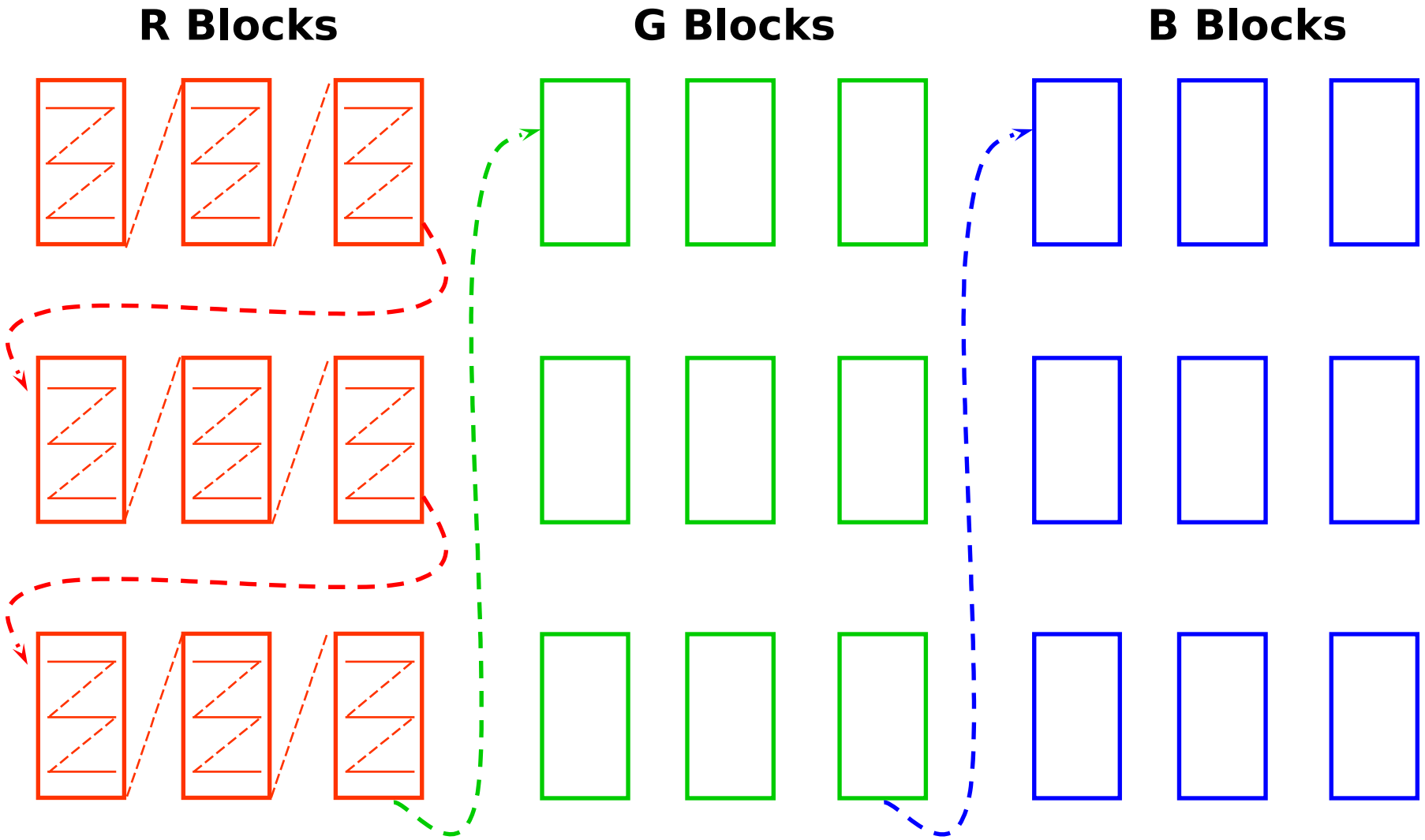
IMODE = R, BAND INTERLEAVED BY ROW THREE BAND COLOR CASE



IMODE = R, BAND INTERLEAVED BY ROW THREE BAND COLOR CASE

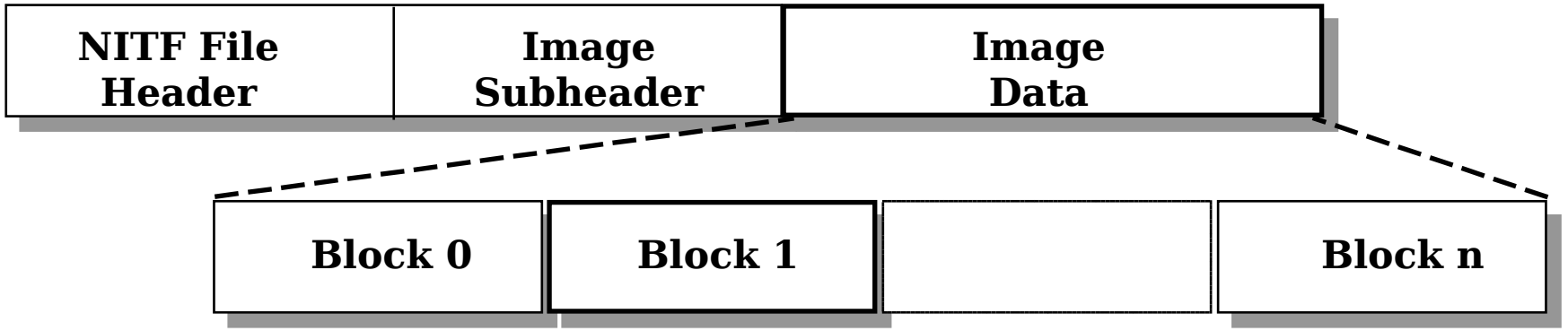


IMODE = S, BAND SEQUENTIAL
THREE BAND COLOR CASE

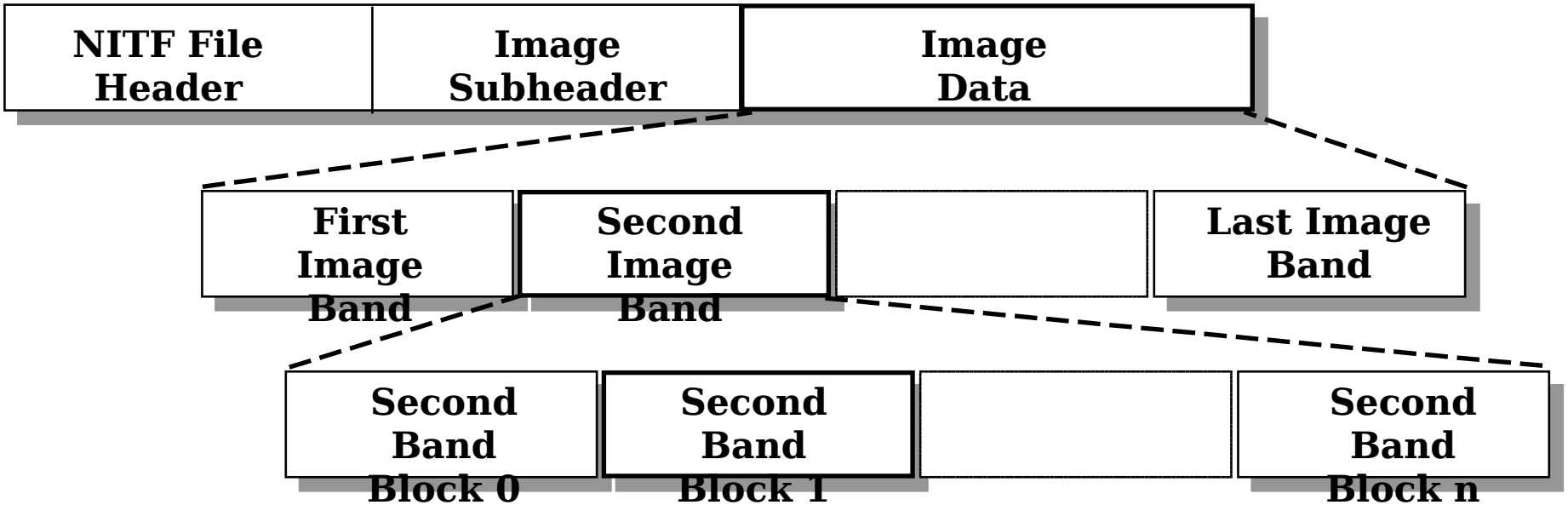


UNCOMPRESSED NITF MULTIPLE BLOCK FILE STRUCTURE

IMODE = B or P



IMODE = S



LUTS

Sample LUT

PIXEL VALUE	RED	GREEN	BLUE	MEANING
00	00000000	11111111	00000000	Green
01	00000000	00000000	11111111	Blue
10	11111111	00000000	00000000	Red
11	11111111	11111111	11111111	White

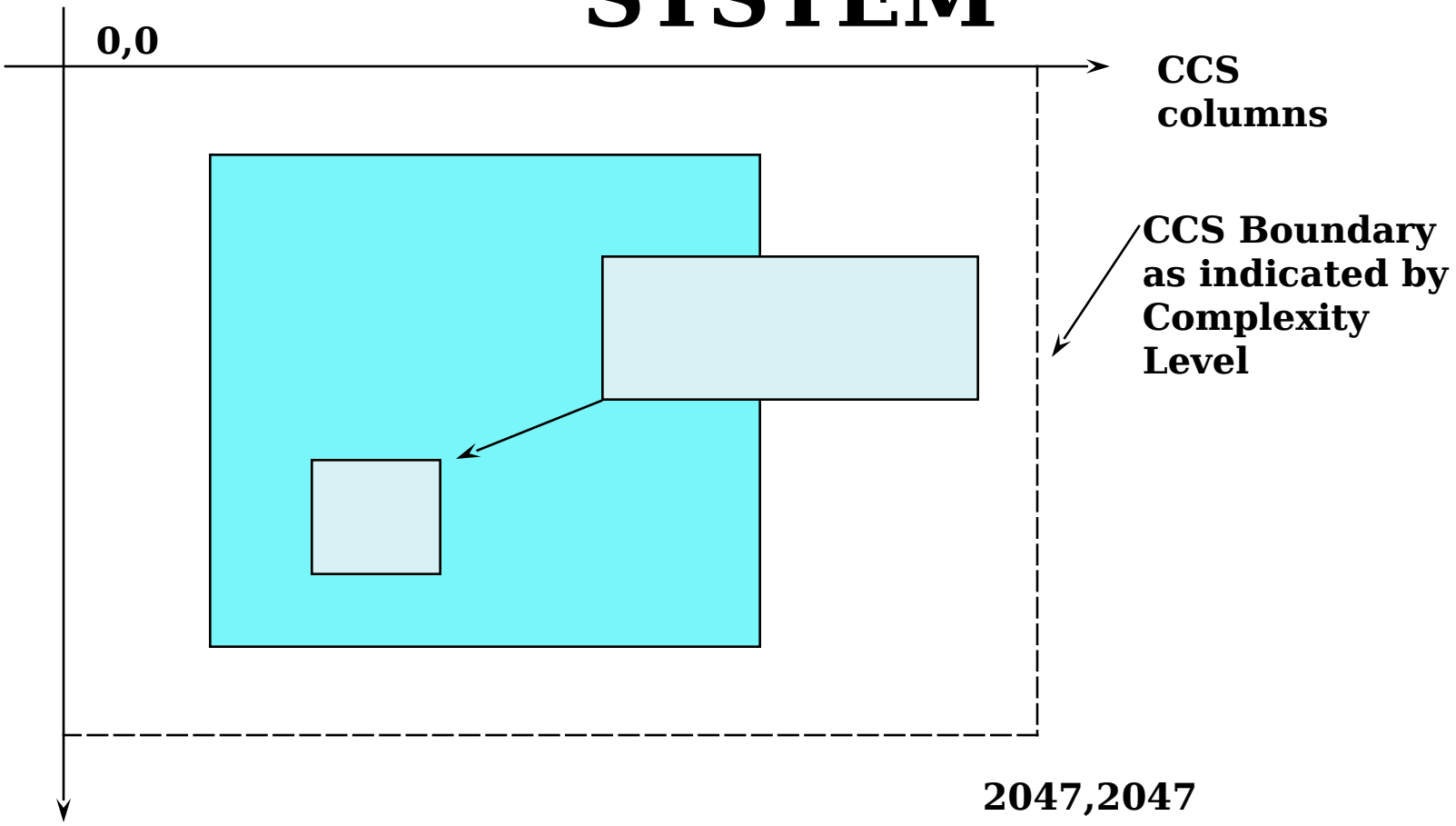
IMAGERY ANNOTATIONS

- **COMPUTER GRAPHICS METAFILE**
- **BIT-MAPPED RASTER (Legacy)**
- **LABELS (Legacy)**
- **OTHER IMAGES**
  - INSET OVERLAY
  - REDUCED RESOLUTION OVERLAY
  - HIGHER RESOLUTION OVERLAY
  - RASTER MAP
  - LEGEND
  - ETC

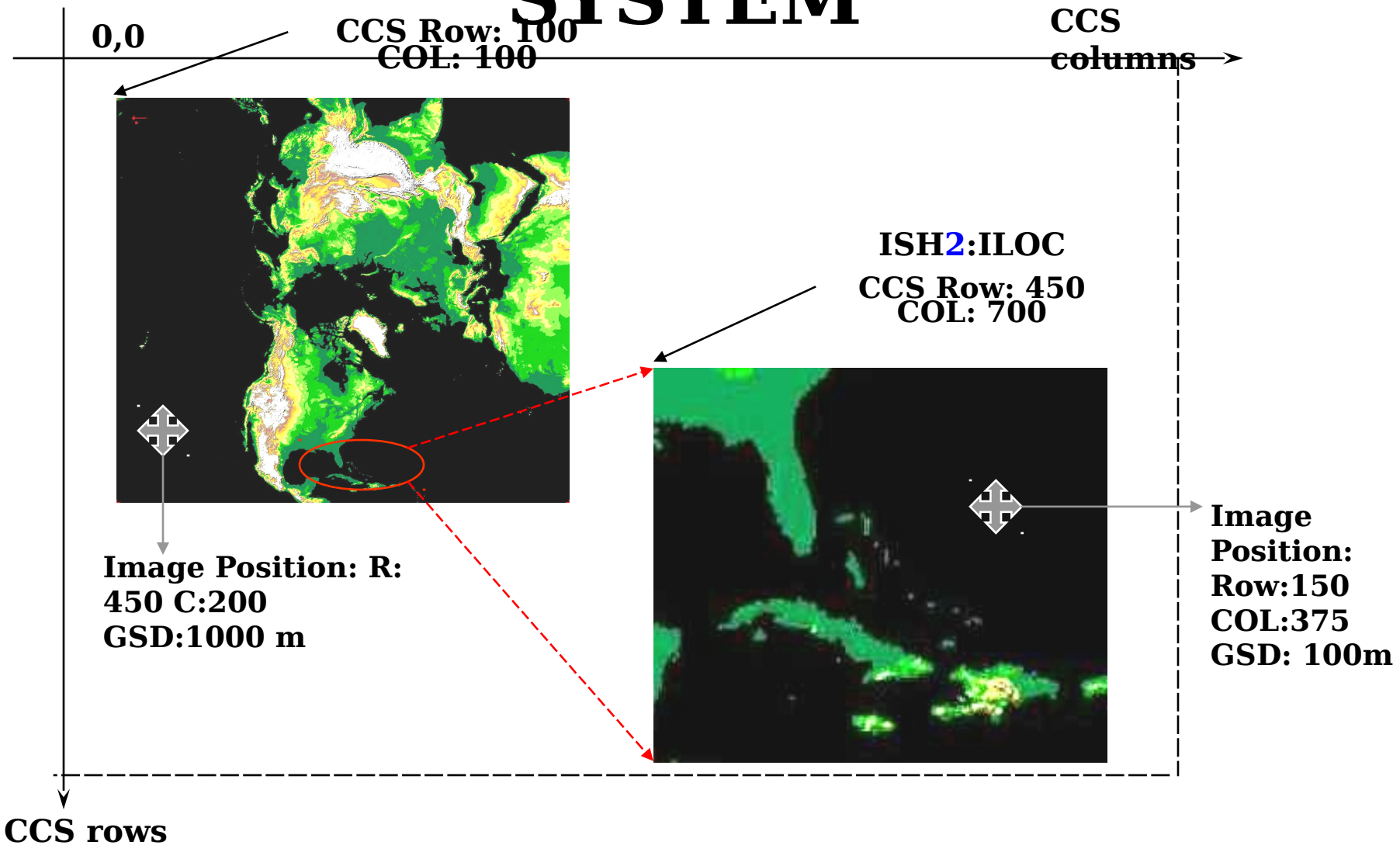
TEXTUAL ADJUNCTS

- **NITF 2.0**
  - STA - Single byte characters, Basic Latin set
  - MTF - MIL-STD-6040, USMTF
    - For example, GRAPHREP Messages
- **NITF 2.1 includes above and adds:**
  - UT1
    - Single byte characters
    - Basic Latin character set
    - Latin Supplement 1 (LS-1) character set
  - U8S
    - UTF-8 character encoding
    - Basic Latin and LS-1 character set

COMMON COORDINATE SYSTEM



COMMON COORDINATE SYSTEM



DISPLAY LEVEL ILLUSTRATION

1. Border (an opaque box) DL = 001

2. Exploited Image DL = 002

3. Classification Marking 1 DL = 999

4. Classification Marking 2 DL = 998

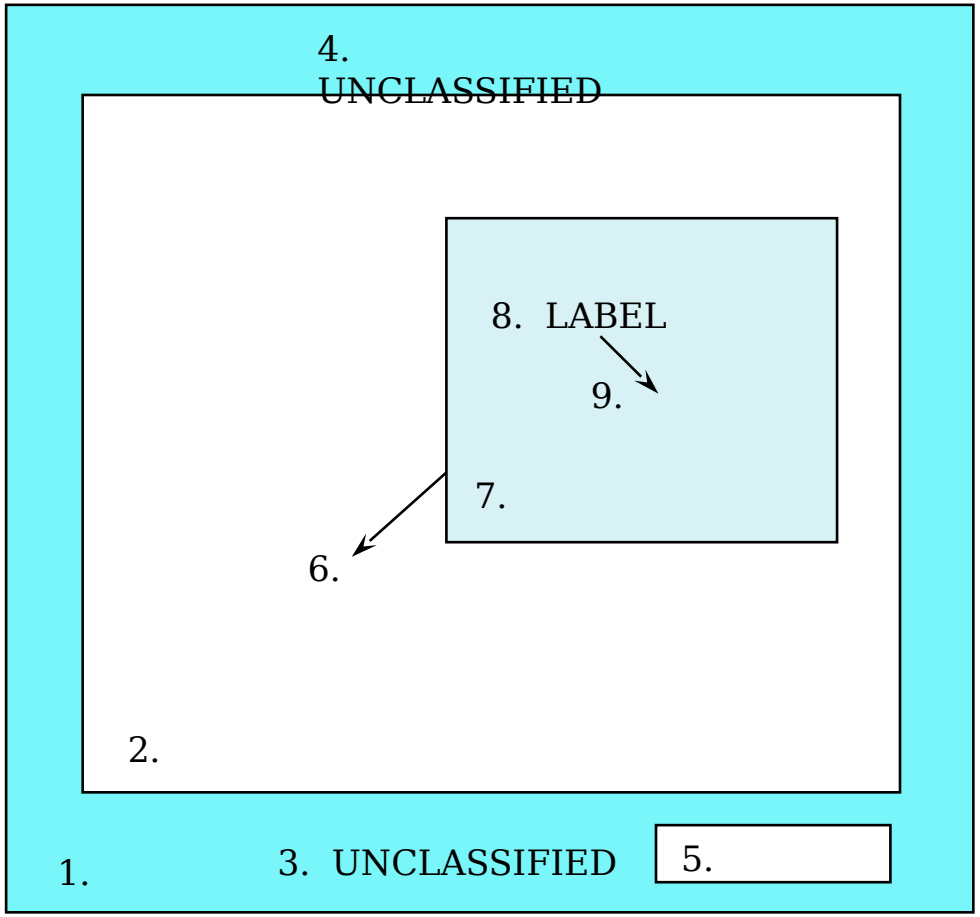
5. Handling Instructions DL = 997

6. Arrow 1 (image inset) DL = 003

7. Image Inset DL = 004

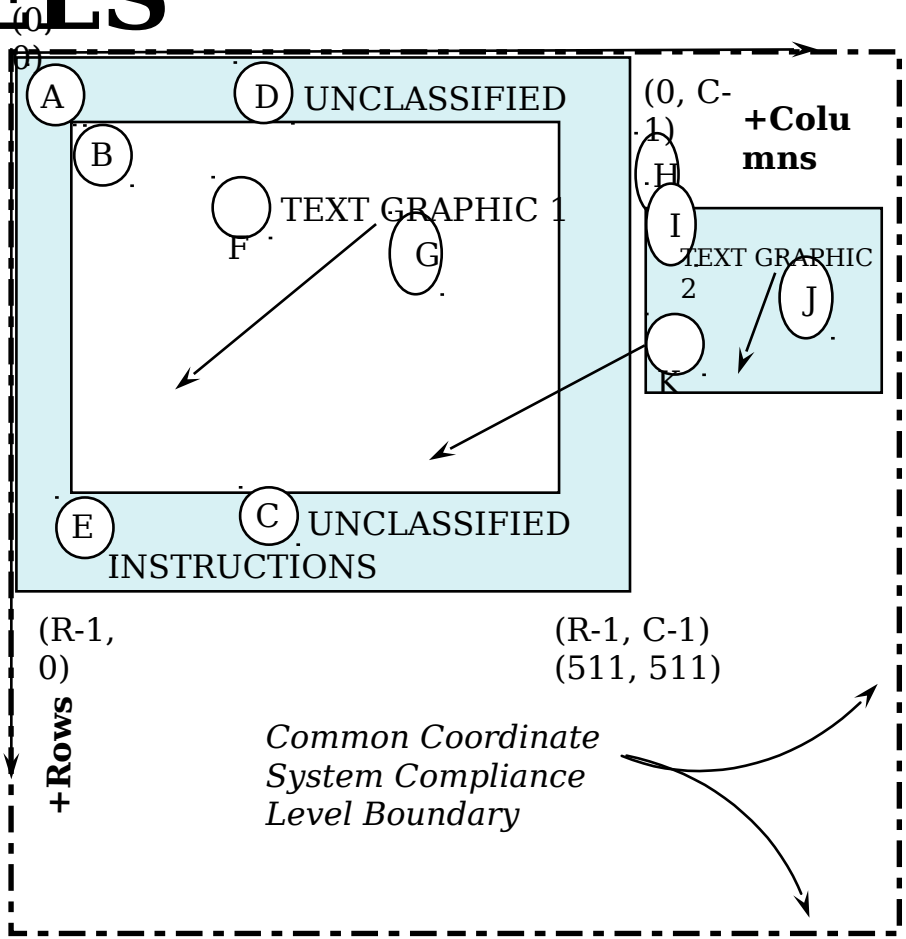
8. Label DL = 005

9. Arrow 2 (label) DL = 006

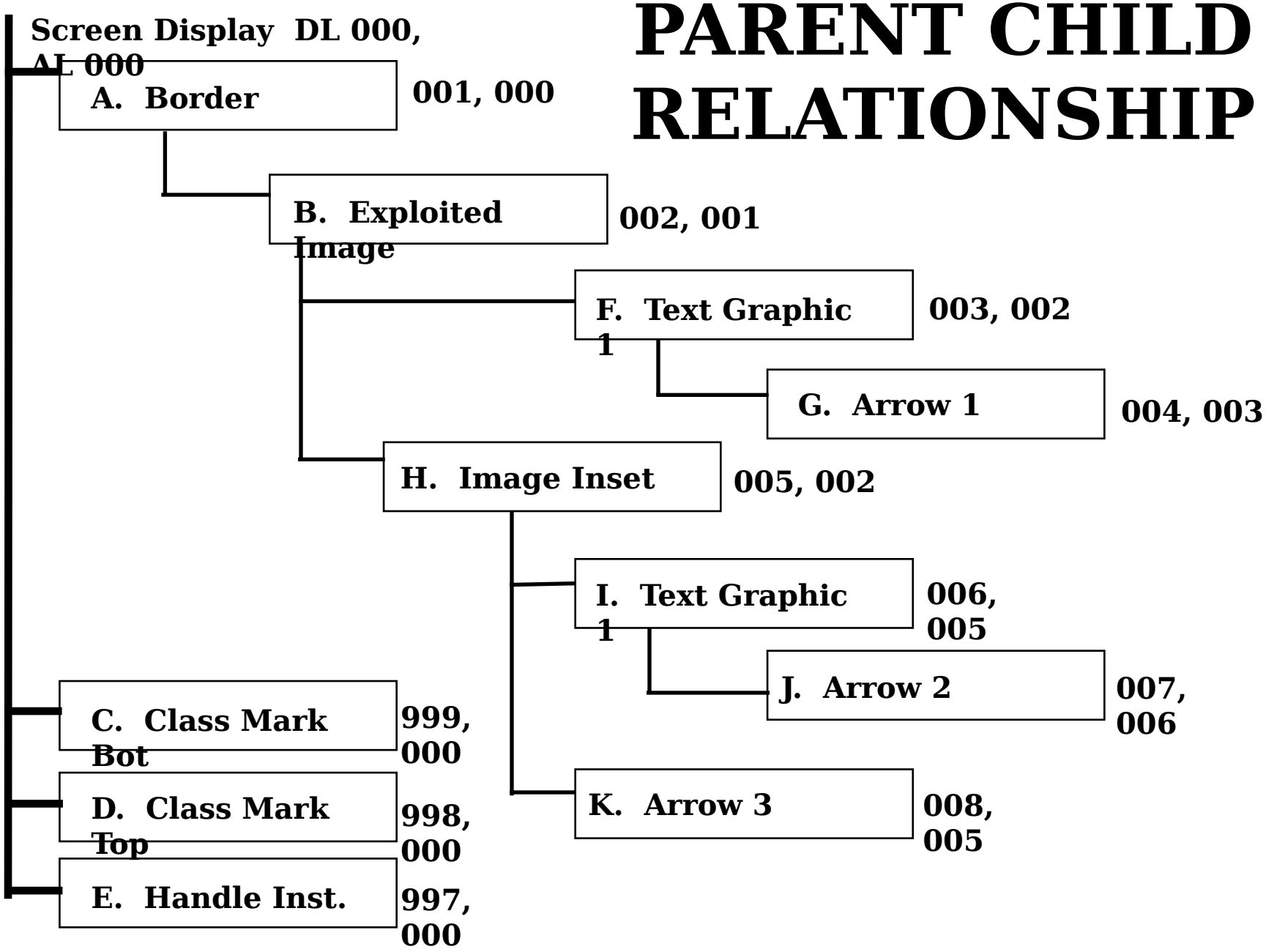


COMMON COORDINATE WITH DISPLAY & ATTACHMENT LEVELS

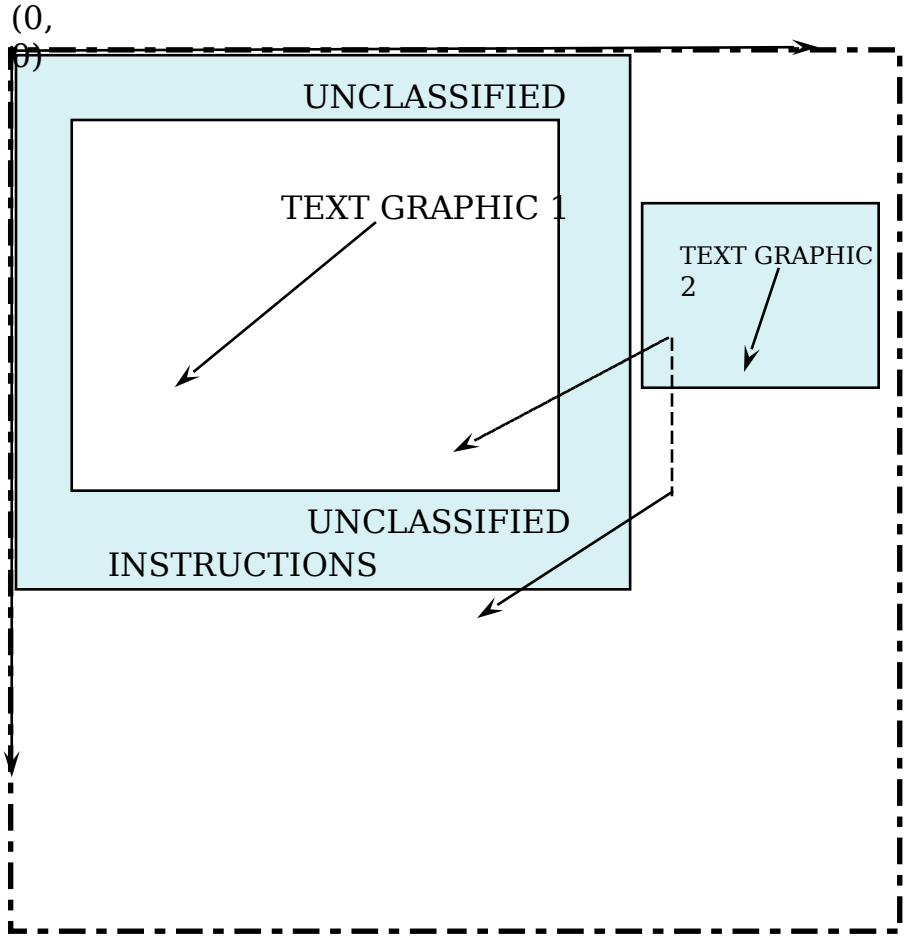
	Offsets		Location	
	DL	**AL**	**Row**	**Column**
A. Border (opaque box)	*001*	*000*	*00000*	*00000*
B. Exploited Image 00025		002	001	00025
C. Classified Marking 1	999	000	00420	00256
D. Classified Marking 2	998	000	00015	00256
E. Handling Instructions	997	000	00440	00040
F. Text Graphic 1 00240		003	002	00060
G. Arrow 1	004	003	00010	00040
H. Image Inset	005	002	00100	00525
I. Text Graphic 2 00050		006	005	00020
J. Arrow 2	007	006	00010	00050
K. Arrow 3	008	005	00070	-0005



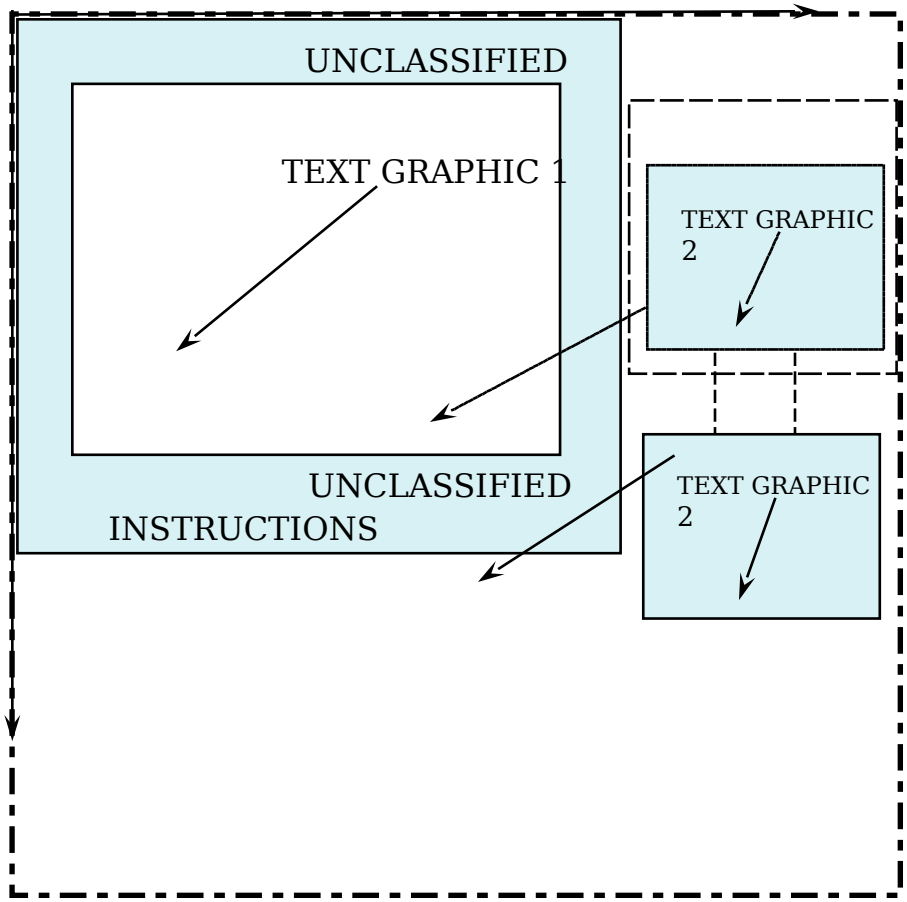
PARENT CHILD RELATIONSHIP



DISPLAY & ATTACHMENT LEVEL PARENT MOVE



DISPLAY & ATTACHMENT LEVEL PARENT CHILD MOVE



DATA EXTENSIONS

- **Flexibility**
- **Extensibility**
- **Types of Extensions: TRE (tag), DES, RES**
- **Example:**

  TRE: Sensors collecting imagery also collect and report auxiliary data that uniquely identifies the imagery, defines the collection geometry and contains other information to aid exploitation.

  DES: Desire to add a new data type for inclusion within an NITF file, perhaps in conjunction with other data types, e.g. a DES for motion imagery.

FORMAT DETAILS

- **Complexity Levels**
- **File Header**
- **Security Markings**
- **Image Subheader**
  - IREP
  - ICAT
  - PVTYPE
- **Image Geographic Location**

COMPLEXITY LEVELS

- **This concept allows NITFS to be implemented on a wide range of hardware platforms with various levels of resources**

NITF 2.1 CLEVEL	NITF 2.0 CLEVEL
09 (Pending)	N/A
07	N/A
06	06
05	05, 04
03	03, 02, 01

- **Implementations of the NITFS are tested according to their ability to pack and/or unpack various CLEVELS of NITFS formatted files**
- **Files shall be marked at the lowest CLEVEL for which they qualify**

COMPLEXITY LEVELS

NITF FILE Features	Complexity Level			
	03	05	06	07
Common Coordinate System Extent (Pixels)	(00000000, 00000000) to (00002047, 00002047)	(00000000, 00000000) to (00008191, 00008191)	(00000000, 00000000) to (00065535, 00065535)	(00000000, 00000000) to (99999999, 99999999)
Maximum File Size	50 Mbyte - 1 byte (52,428,799 bytes)	1 Gbyte - 1byte (1,073,741,823 bytes)	2 Gbyte -1byte (2,147,483,647 bytes)	10 Gbyte - 1 byte (10,737,418,239 bytes)
Image Size (Image(s) placed within CCS extent)	00000002 to 00002048 Rows X 00000002 to 00002048 Columns (R and C ≤ 2048)	00000002 to 00008192 Rows X 00000002 to 00008192 Columns (R or C >2048)	00000002 to 00065536 Rows X 00000002 to 00065536 Columns (R or C >8192)	00000002 to 99999999 Rows X 00000002 to 99999999 Columns (R or C >65536)
Image Blocking (Rectangular Blocks allowed)	Single and Multiple Blocks 0001 to 2048 Rows X 0001 to 2048 Cols	Single and Multiple Blocks 0001 to 8192 Rows X 0001 to 8192 Cols	Multiple blocking is mandatory for images that exceed 8192 pixels per Row or Column 0001 to 8192 Rows X 0001 to 8192 Columns	

COMPLEXITY LEVELS (CONT'D)

NITF FILE Features	Complexity Level			
	03	05	06	07
Multispectral (MULTI) No Compression	2 to 9 Bands 8,16, 32, 64-Bits per pixel per band With and without LUT in each band IC=NC, NM IMODE = B, P R, S	2 to 255 Bands, 8, 16, 32, 64-Bits per pixel per band With and without LUTs in each band IC=NC, NM IMODE = B, P R, S		2 to 999 Bands 8,16, 32, 64-Bits per pixel per band With and without LUTs in each band IC=NC, NM IMODE = B, P R, S
Multispectral (MULTI) Individual Band JPEG Compression	2 to 9 Bands 8, 12-Bits per Pixel per Band No LUT IMODE = B, S IC = C3, M3	2 to 255 Bands, 8, 12 Bits per Pixel per Band No LUT IMODE = B, S IC = C3, M3		2 to 999 Bands 8, 12-bits per Pixel per Band No LUT IMODE = B, S IC = C3, M3
Multispectral (MULTI) Multi-Component Compression	2 to 9 Bands 8, 12-Bits per Pixel per Band No LUT IMODE = B, P, S IC = C6, M6 (This feature is optional for implementation)	2 to 256 Bands, 8, 12-Bits per Pixel per Band With and without LUT in each Band IMODE = B, P, S IC = C6, M6 (This feature is optional for implementation)		2 to 999 Bands 8, 12-Bits per Pixel per Band No LUT IMODE = B, P, S IC = C6, M6 (This feature is optional for implementation)

COMPLEXITY LEVELS (CONT'D)

NITF FILE Features	Complexity Level			
	03	05	06	07
Matrix Data (NODISPLY)	1 to 9 Bands 8, 16, 32, 64-Bits per pixel per band No LUT in any band IMODE = B.P, R, S (This feature is optional for implementation)	1 to 255 Bands, 8, 16, 32, 64-Bits per pixel per band No LUT in any band IMODE = B, P, R, S (This feature is optional for implementation)		1 to 999 Bands 8, 16, 32, 64-Bits per pixel per band No LUT in any band IMODE = B, P, R, S (This feature is optional for implementation)
Number of Image Segments Per File	0 - 20	0 - 100		
Aggregate Size of Graphic Segments Per File	1 Mbyte maximum	2 Mbyte maximum		

NITF 2.1 FILE HEADER

NITF File Header	Image Segments	Graphic Segments	Text Segments	Data Extension Segments	Reserved Extension Segments

FIELD	SIZE	VALUE RANGE	TYPE
FHDR	4	NITF	R
FVER	5	02.10	R
CLEVEL	2	03, 05, 06, 07	R
STYPE	4	BF01	R
OSTAID	10	(Originating Station Identifier)	R
FDT	14	CCYYMMDDhhmmss	R
FTITLE	80	(Default is spaces)	R
FSCLAS	1	T, S, C, R, or U	R
SECURITY GROUP	166	(Detail shown in another table)	R
FSCOP	5	00000-99999, (Default is 00000)	R
FSCPYS	5	00000-99999, (Default is 00000)	R

NITF 2.1 FILE HEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
ENCRYP	1	0 = Not Encrypted	R
FBKGC	3	Unsigned binary integer for RGB color (0x00-0xFF, 0x00-0xFF, 0x00-0xFF)	R
ONAME	24	(Default is spaces)	R
OPHONE	18	(Default is spaces)	R
FL	12	000000000388-999999999998, 999999999999	R
HL	6	000388-999999	R
NUMI	3	(Default is BCS zeros) 000-999	R
LISHn	6	000439-999998, 999999	C
LIn	10	0000000001-9999999998, 9999999999	C

NITF 2.1 FILE HEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
NUMS	3	(Default is BCS zeros) 000-999	R
LSSHn	4	0258-9998, 9999	C
LSn	6	000001-999998, 999999	C
NUMX	3	000	R
NUMT	3	(Default is BCS zeros) 000-999	R
LTSHn	4	0282-9998, 9999	C
LTn	5	00001-99998, 99999	C
NUMDES	3	(Default is BCS zeros) 000-999	R
LDSHn	4	0200-9998, 9999	C
LDn	9	000000001-999999998, 999999999	C

NITF 2.1 FILE HEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
NUMRES	3	(Default is BCS zeros) 000-999	R
LRESHn	4	0200-9999	C
LREn	7	0000001-9999999	C
UDHDL	5	(Default is BCS zeros) 00000 or 00003-99999	R
UDHOFL	3	(Default is BCS zeros) 000-999	C
UDHD	*[1]	Tagged Record Extensions	C
XHDL	5	(Default is BCS zeros) 00000 or 00003-99999	R
XHDLOFL	3	(Default is BCS zeros) 000-999	C
XHD	**[1]	Tagged Record Extensions	C

*1 A value specified in the UDHDL field minus 3 (in bytes)

**1 A value specified in the XHDL field minus 3 (in bytes)

NUMI EXAMPLE

- NUMI = 3
  - LISH001 = 000XXX
  - LI001 = 00000YYYYY
  - LISH002 = 000XXX
  - LI002 = 0000000YYY
  - LISH003 = 000XXX
  - LI003 = 0000000YYY

Image Segment #1		Image Segment #2		Image Segment #3	
000XXX Image #1 Subheader	00000YYYYY Image #1 Image Data	000XXX Image #2 Subheader	0000000YYY Image #2 Image Data`	000XXX Image #3 Subheader	0000000YYY Image #3 Image Data

SECURITY

- Main Header contains overall security classification of file.
- Each data segment has individual security classification.
- Security group within the Main Header and each data segment contains:

NITF 2.0
- Classification
- Codewords
- Control and Handling
- Releasing Instructions
- Classification Authority
- Security Control Number
- Security Downgrading Instructions
-
-
-
-
-
-
-

NITF 2.1
- Classification
- Codewords
- Control and Handling
- Releasing Instructions
- Declassification Type
- Declassification Date
- Declassification Exemption
- Downgrade
- Downgrade Date
- Classification Text
- Classification Authority Type
- Classification Authority
- Classification Reason
- Security Source Date
- Security Control Number

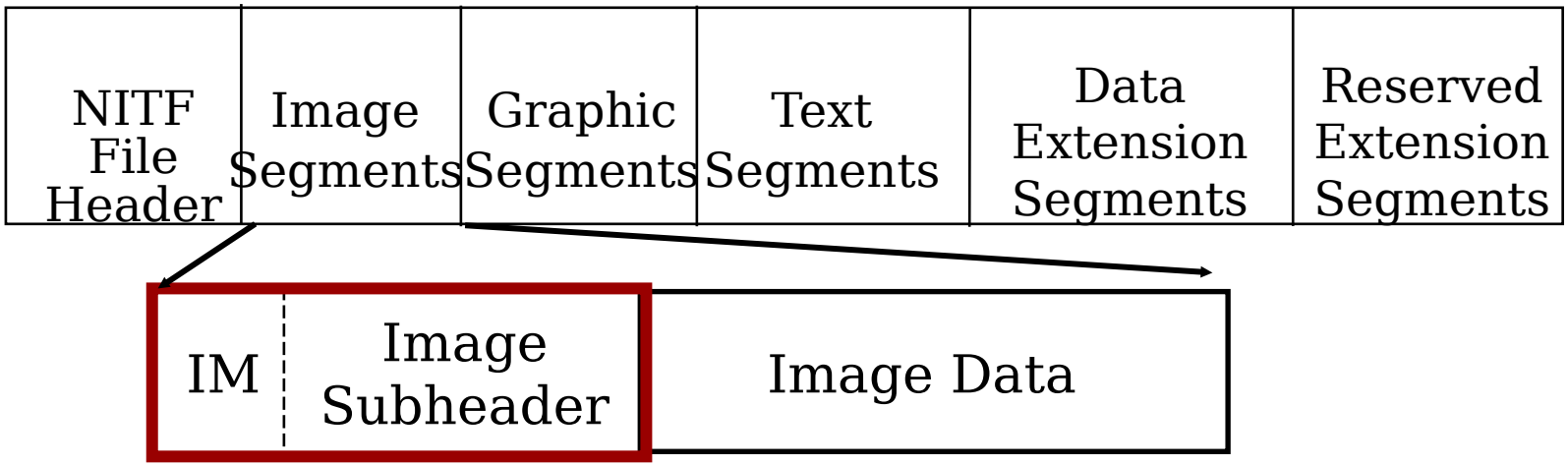
SECURITY (CONT'D)

System Security Group - 166 bytes		
XSCLSY	2 bytes	Security Classification System
XSCODE	11 bytes	Codewords
XSCTLH	2 bytes	Control and Handling
XSREL	20 bytes	Releasing Instructions
XSDCTP	2 bytes	Declassification Type, DD, DE, GD, GE, O, or X
XSDCDT	8 bytes	Declassification Date, CCYYMMDD
XSDCXM	4 bytes	Declassification Exemption, X1-X8 and X251-X259
XSDG	1 byte	Downgrade, S, C, or R

SECURITY (CONT'D)

System Security Group - 166 bytes		
XSDGDT	8 bytes	Downgrade Date, CCYYMMDD
XSCLTX	43 bytes	Classification Text
XSCATP	1 byte	Classification Authority Type, O or D
XSCAUT	40 bytes	Classification Authority
XSCRSN	1 byte	Classification Reason, A-G
XSSRDT	8 bytes	Security Source Date, CCYYMMDD
XSCTLN	15 bytes	Security Control Number

2.1 IMAGE SUBHEADER



FIELD	SIZE	VALUE RANGE	TYPE
IM	2	IM	R
IID1	10	User defined	R
IDATIM	14	CCYYMMDDhhmmss	R
TGTID	17	BBBBBBBBBBOOOOOCC (Default is BCS spaces)	R
IID2	80	(Default is BCS spaces)	R
ISCLAS	1	T, S, C, R, or U	R
Security Group	166	(Detail shown in another table)	R

...

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
ENCRYP	1	0=Not Encrypted	R
ISORCE	42	(Default is BCS spaces)	R
NROWS	8	00000002-99999999	R
NCOLS	8	00000002-99999999	R
PVTYPE	3	INT, B, SI, R, C	R
IREP	8	MONO, RGB, RGB/LUT, MULTI, NODISPLY, NVECTOR, POLAR, VPH, YCbCr601	R
ICAT	8	VIS, SL, TI, FL, RD, EO, OP, HR, HS, CP, BP, SAR, SARIQ, IR MAP, MS, FP, MRI, XRAY, CAT, VD, PAT, LEG, DTEM, MATR, LOCG, BARO, CURRENT, DEPTH, WIND (Default is VIS)	R

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
ABPP	2	01-96	R
PJUST	1	L or R (Default is R)	R
ICORDS	1	U, G, N, S, D, or space (Default is BCS spaces)	R
IGEOLO	60	±dd.ddd±ddd.ddd (four times) or ddmmssXdddmmssY (four times) or zzBJKeeeeennnnn (four times) or zzeeeeeennnnnnn (four times)	C
NICOM	1	0-9	R
ICOMn	80	User defined	C

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
IC	2	NC, NM, C1, C3, C4, C5, C6, C7, C8 M1, M3, M4, M5, M6, M7, M8	R
COMRAT	4	(Depends on the value of the IC field)	C
NBANDS	1	0-9	R
XBANDS	5	00010-99999	C
IREPBANDn	2	Standard values are LU, R, G, B, M, Y, Cb, Cr Additional values are allowed through the registration process	R
ISUBCATn	6	I, Q, M, P, SPEED, DIRECT, User defined (Default is spaces)	R
IFCn	1	N	R
IMFLTn	3	Fill with BCS spaces	R

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
NLUTSn	1	0-4	R
NELUTn	5	00001-65536	C
LUTDnm	?[3]	Unsigned binary integer, LUT Values	C
ISYNC	1	0 = No Sync Code	R
IMODE	1	B, P, R, S	R
NBPR	4	0001-9999	R
NBPC	4	0001-9999	R
NPPBH	4	0001-8192	R
NPPBV	4	0001-8192	R
NBPP	2	01-96	R

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
IDLVL	3	001-999	R
IALVL	3	000-998 (Default is BCS zeros)	R
ILOC	10	00000 to 99999 or -0001 to -9999	R
IMAG	4	decimal value, /2 followed by 2 spaces, /4 followed by 2 spaces, /8 followed by 2 spaces, /16 followed by a space, /32 followed by a space, /64 followed by a space, or /128 (Default is 1.0 followed by a space)	R

2.1 IMAGE SUBHEADER (CONT'D)

FIELD	SIZE	VALUE RANGE	TYPE
UDIDL	5	00000 or 00003-99999	R
UDOFL	3	000-999	C
UDID	*3	Tagged Record Extensions	C
IXSHDL	5	00000 or 00003-99999	R
IXSOFL	3	000-999	C
IXSHD	**3	Tagged Record Extensions	C

3 One Byte for each entry
*3 As specified in UDIDL
**3 As specified in IXSHDL

PIXEL VALUE TYPE

- PVTYPE - Indicates the computer representation used for the value of each pixel or:
  - INT - Integer
  - SI - Signed Integer
  - B - Binary
  - C - Complex
  - R - Real

IMAGE REPRESENTATION

IREP - Indicates the processing required to display the image.

- MONO
- RGB
- YCbCr601
- POLAR
- RGB/LUT
- MULTI
- NODISPLY

IMAGE REPRESENTATION

IREP	PVTYPE	ICAT
MONO	B or INT	VIS, OP, SL, TI, FL, RD, EO, HR, BP, FP, VD, SAR, IR
RGB/LUT	INT	VIS, OP, MAP, LEG, CP, PAT, EO
RGB	INT	VIS, OP, MAP, LEG, CP, PAT, EO
YCbCr	INT	VIS, OP, MAP, LEG, CP, PAT, EO
MULTI	INT, SI, R	HS, MS
NODISPLY	INT, SI, R, C	DTEM, LOCG, MATRIX, SARIQ, BARO, CURRENT, DEPTH, WIND

IMAGE CATEGORY

ICAT - Indicates the specific category of image, raster or grid data, or the use or nature of the collector.

- VIS - Visible Imagery
- SL - Side Looking Radar
- TI - Thermal Infrared
- FL - Forward Looking
- MS - Multispectral
- HS - Hyperspectral
- CP - Color Frame Photography
- VD - Video
- RD - Radar
- EO - Electro-Optical
- OP - Optical
- HR - High Resolution Radar
- BP - Black and White Frame Photography
- SAR - Synthetic Aperture Radar

IMAGE CATEGORY (CONT'D)

- SARIQ - Synthetic Aperture Radar radio hologram
- PAT - Colour patch
- DTEM - Elevation model data
- MATR - General matrix data
- BARO - Barometric
- CURRENT - Current
- DEPTH - Depth
- WIND - Wind
- LOCG - Location grids

IGEOLO/ICORDS

Corner Coordinates do not provide accuracy of data. Simply
Four (4) points of a bounding polygon to indicate area of coverage.

NITF 2.0:

U = UTM

G = Geodetic

C = Geocentric

N = None

NITF 2.1:

U = UTM, in MGRS

G = Geographic (Deg, min, sec)

S = UTM (Southern Hemisphere)

D = Decimal Degrees

N = UTM (Northern Hemisphere)

COMPRESSION

- **OBJECTIVES OF COMPRESSION**
- **ARIDPCM (NITF 1.1 only)**
- **BI-LEVEL (Phasing out of NITFS)**
- **JPEG**
- **VQ**
- **JPEG 2000**
- **FUTURE**

OBJECTIVES OF IMAGE COMPRESSION

- Image compression is the art/science of finding efficient representations for digital images in order to:
  - Reduce the memory required for their storage,
  - Reduce the effective data access time when reading from storage devices,
  - Reduce the bandwidth and/or the time required for their transfer across communication channels.
- The goal is to achieve the desired bit rate without compromising the image quality required for a given application.

WHY CAN IMAGES BE COMPRESSED?

- **Redundancy**
  - Redundancy relates to the statistical and information theoretic properties of an image.
  - Redundancy can be found in various forms:
    - Spatial (between neighboring pixels),
    - Spectral (between color planes), and
    - Temporal (between neighboring sequential frames in a sequence).
- **Irrelevancy**
  - Irrelevancy relates to perception and the limitations of the interpreting system, e.g. the human visual system (HVS)
  - The HVS exhibits sensitivity variations as a function of:
    - Spatial and temporal frequency, wavelength, light level, orientation, and surrounding signals (masking).

BASIC STRATEGY IN IMAGE COMPRESSION

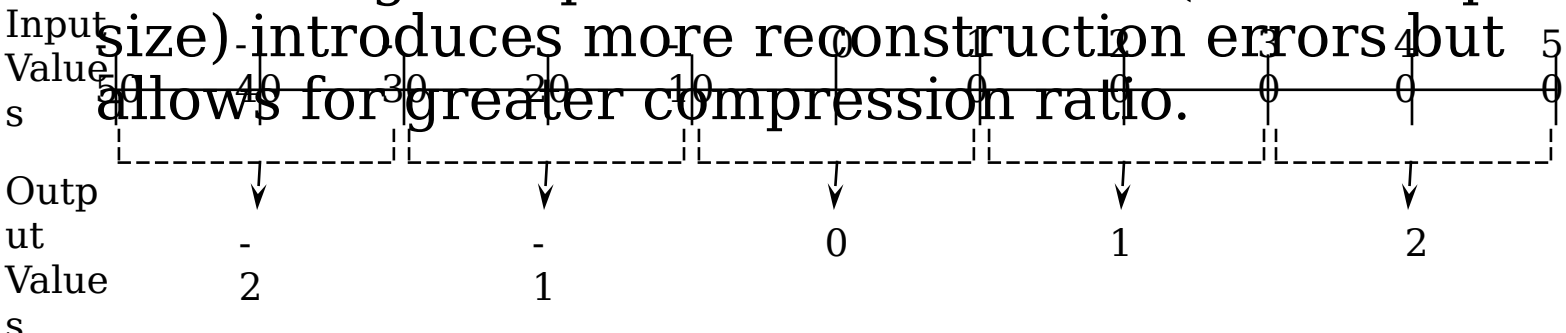
- Ideally, an image compression technique removes redundant and/or irrelevant information, and efficiently encodes what remains.
- Practically, it is often necessary to throw away both non-redundant information and relevant information to achieve the required compression.
- In either case, the trick is finding methods that allow important information to be efficiently extracted and represented.

TYPES OF COMPRESSION

- **Lossless (Reversible)**
  - The reconstructed image is numerically identical to the original image on a pixel-by-pixel basis.
  - Only a modest amount of compression can be achieved (2:1)
- **Lossy (Irreversible)**
  - The reconstructed image contains degradations relative to the original image, and lower bit rates can be achieved by allowing more degradations.
  - Visually lossless is used to describe lossy compression schemes that result in no "visible" degradations (which is highly dependent on the image, display, and observer).

QUANTIZATION

- Quantization is a many-to-one mapping that reduces the number of possible signal values (which reduces bit rate) at the cost of introducing errors (that reduce image quality).
  - It is the key component that distinguishes lossy compression from lossless compression
- A scalar quantizer individually quantizes each signal value.
- Quantization allows us to trade-off image quality for a lower bit rate.
  - Increasing the quantization bin size (a.k.a. step size) introduces more reconstruction errors but allows for greater compression ratio.



SYMBOL ENCODING

- Symbol encoding involves assigning a binary codeword to each possible quantized value
  - Is typically a lossless step, even in lossy compression
- Fixed-Length Codes
  - The number of bits/symbol is constant (constant data rate)
  - This is inefficient if the number of symbols is not a power of two, or if the symbol probabilities are not equal
  - Less sensitive to communication errors
- Variable-Length Codes
  - The number of bits/symbol is variable (variable data rate)
  - Generally, this is much more efficient than fixed-length coding
  - Variable-length coding techniques include

ARIDPCM

- **Adaptive Recursive Interpolative Differential Pulse Code Modulation (ARIDPCM)**
- **MIL-STD-188-197A**
  - **Used only in NITF Version 1.1**
  - **Single band, 8 bits-per-pixel, grayscale imagery**
  - **Image sizes up to 512 x 512 pixels**
  - **Suitable for 286 or higher processor**
  - **Used while awaiting completion of ISO/JPEG**

BI-LEVEL

- **MIL-STD-188-196**
- **ITU-T RECOMENDATION T.4 AMD2**
  - **Standard for Group III Facsimile**
  - **Single band, 1 bit per pixel (Bi-Tonal)**
  - **Black and White or with 2-color LUT**
  - **Image sizes up to 2560 samples x 8192 lines**
  - **Suitable for 286 or higher processor**
  - **Images of document pages or hand drawn sketches**
  - **Being phased out of NITFS; use JPEG 2000**

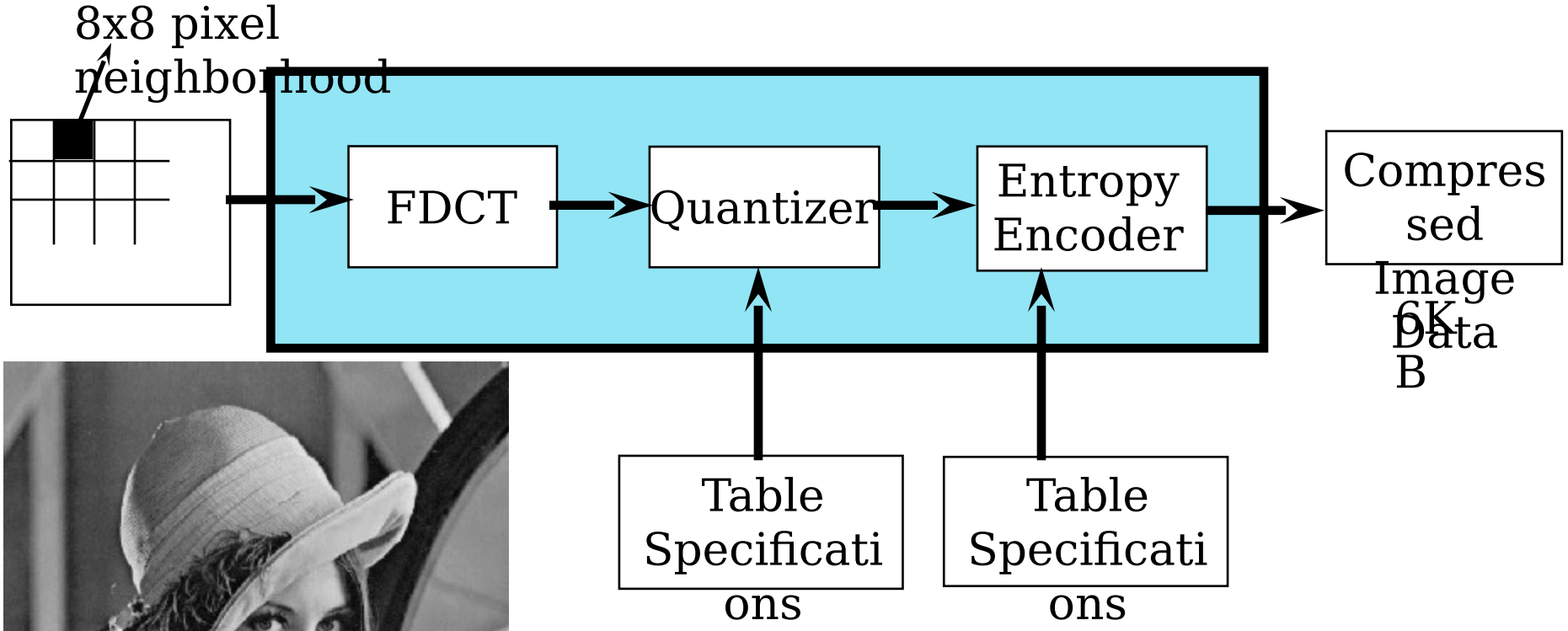
JPEG

- **MIL-STD-188-198A**
- **ISO/IEC 10918-1**
  - **DCT Lossy**
    - **8 bit-per-pixel precision**
    - **12 bit-per-pixel precision**
  - **Lossless**
  - **Downsample JPEG (NIMA Method 4)**
  - **Grayscale and Color Imagery**
  - **Images up to 8K x 8K when unblocked**
  - **Images up to 64K x 64K when blocked**
  - **Suitable for 386 or higher processor**

JPEG (cont'd)

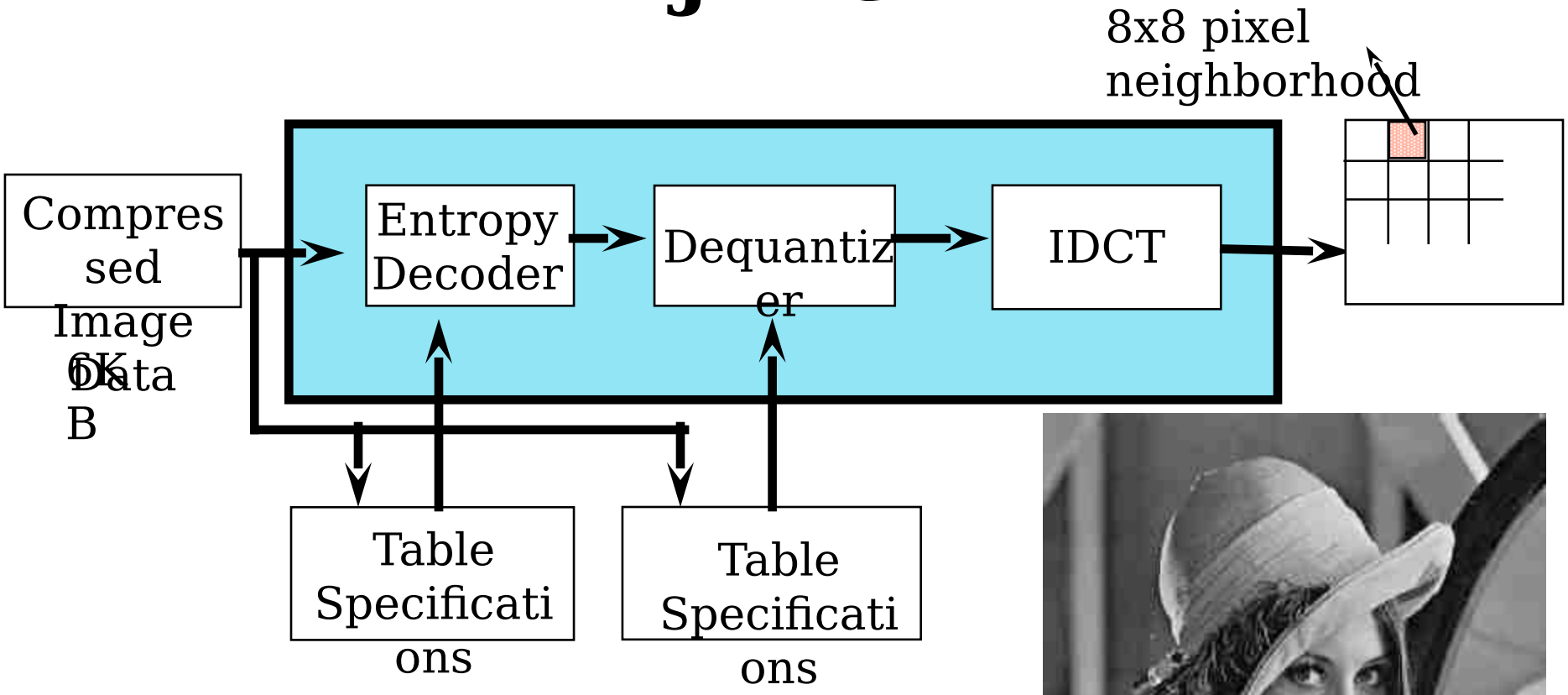
- **Standardized Quantization Tables for:**
  - **General Purpose Grayscale**
  - **General Purpose Color**
  - **Visual/EO**
  - **Infrared**
  - **Detected SAR**
  - **NIMA Method 4 Grayscale**
- **Five levels of quality for each image type**
- **Provisions for ‘Custom’ Tables when needed**

DCT - BASED ENCODER JPEG



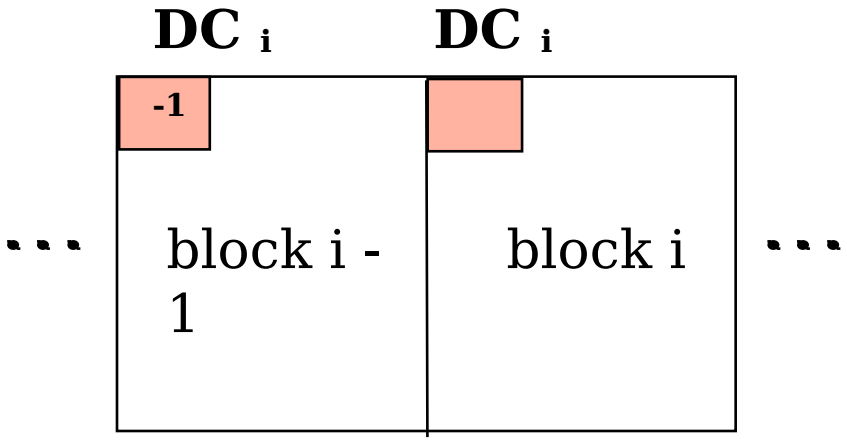
6K
B

IDCT - BASED DECODER JPEG

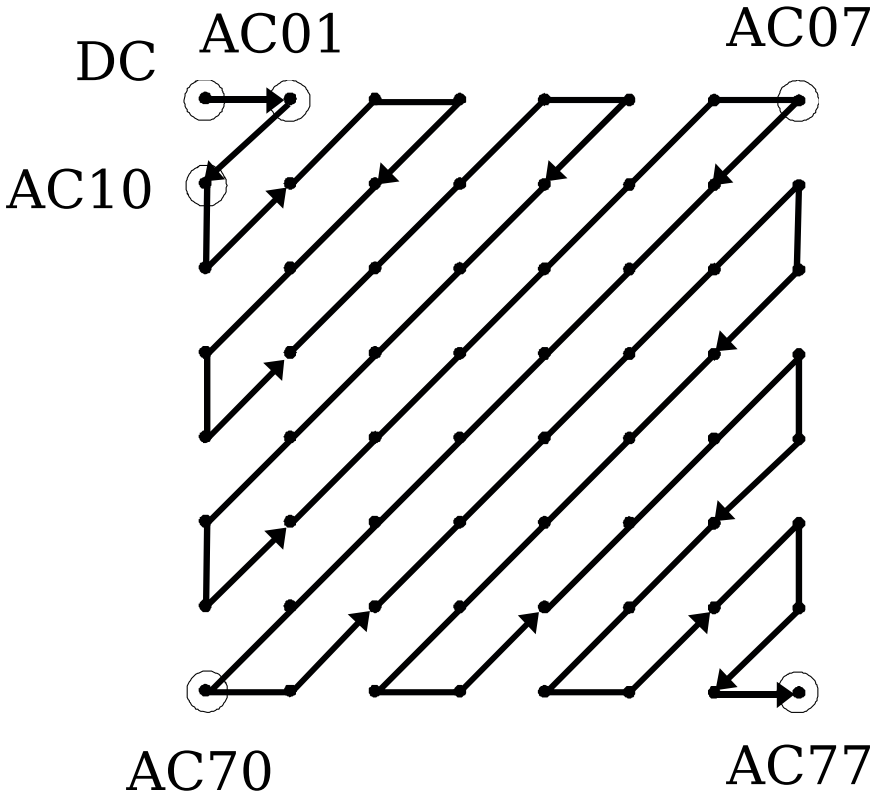


COMPARISON

PREPARATION OF QUANTIZED COEFFICIENTS FOR ENTROPY ENCODING

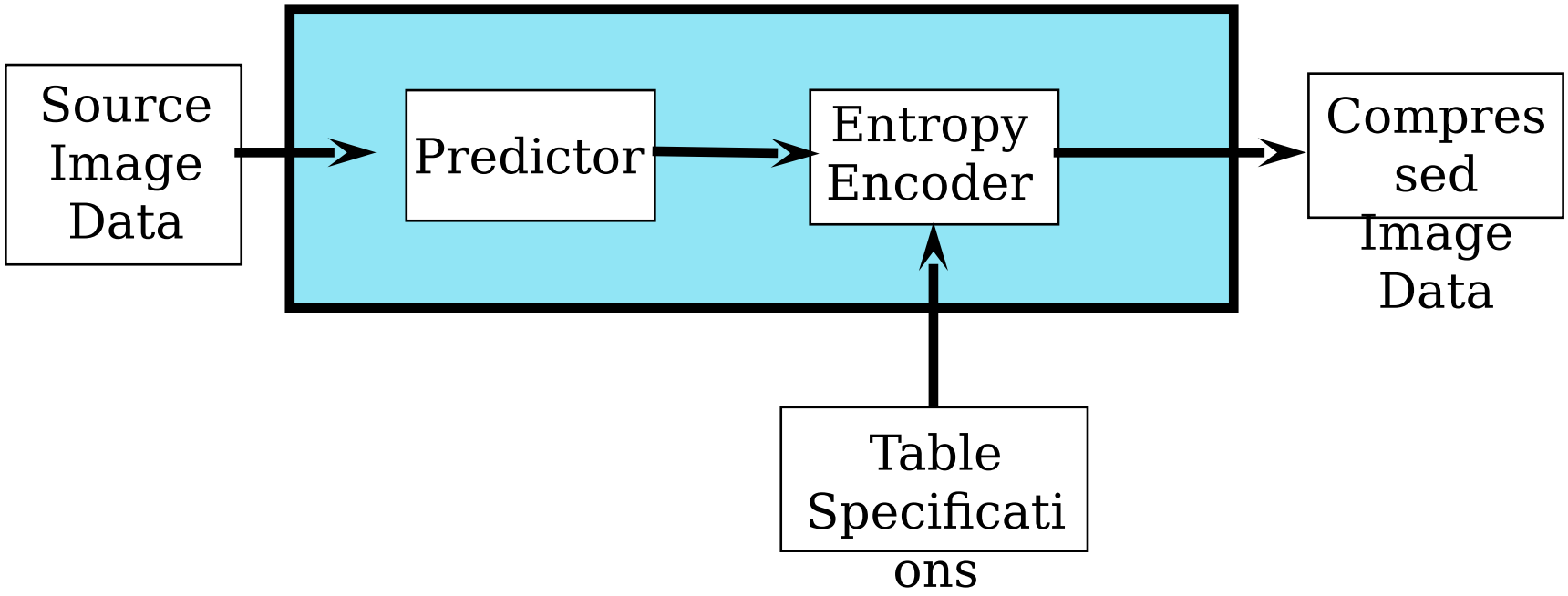


Differential DC Encoding

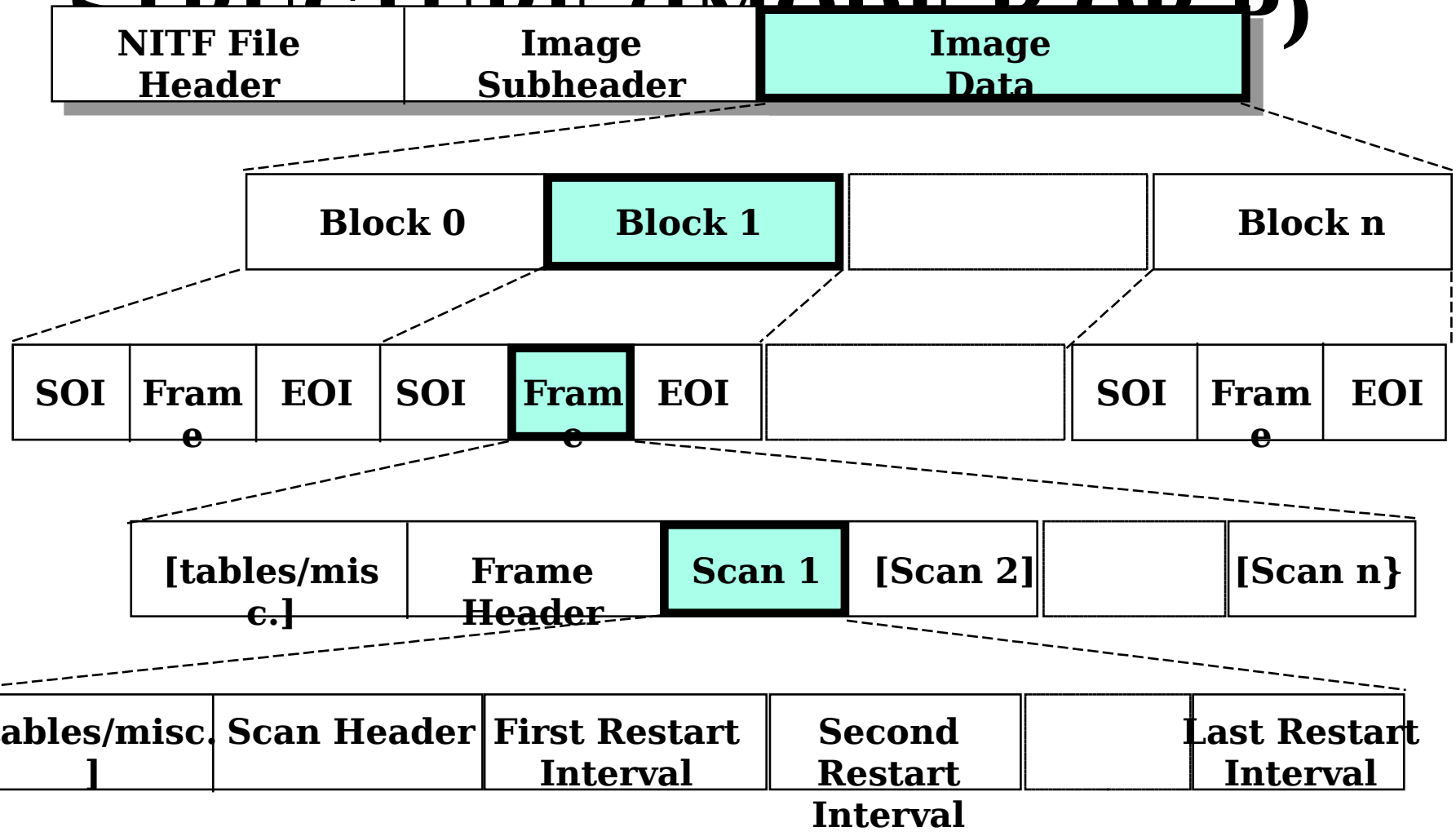


ZIG-ZAG ORDER

LOSSLESS ENCODER

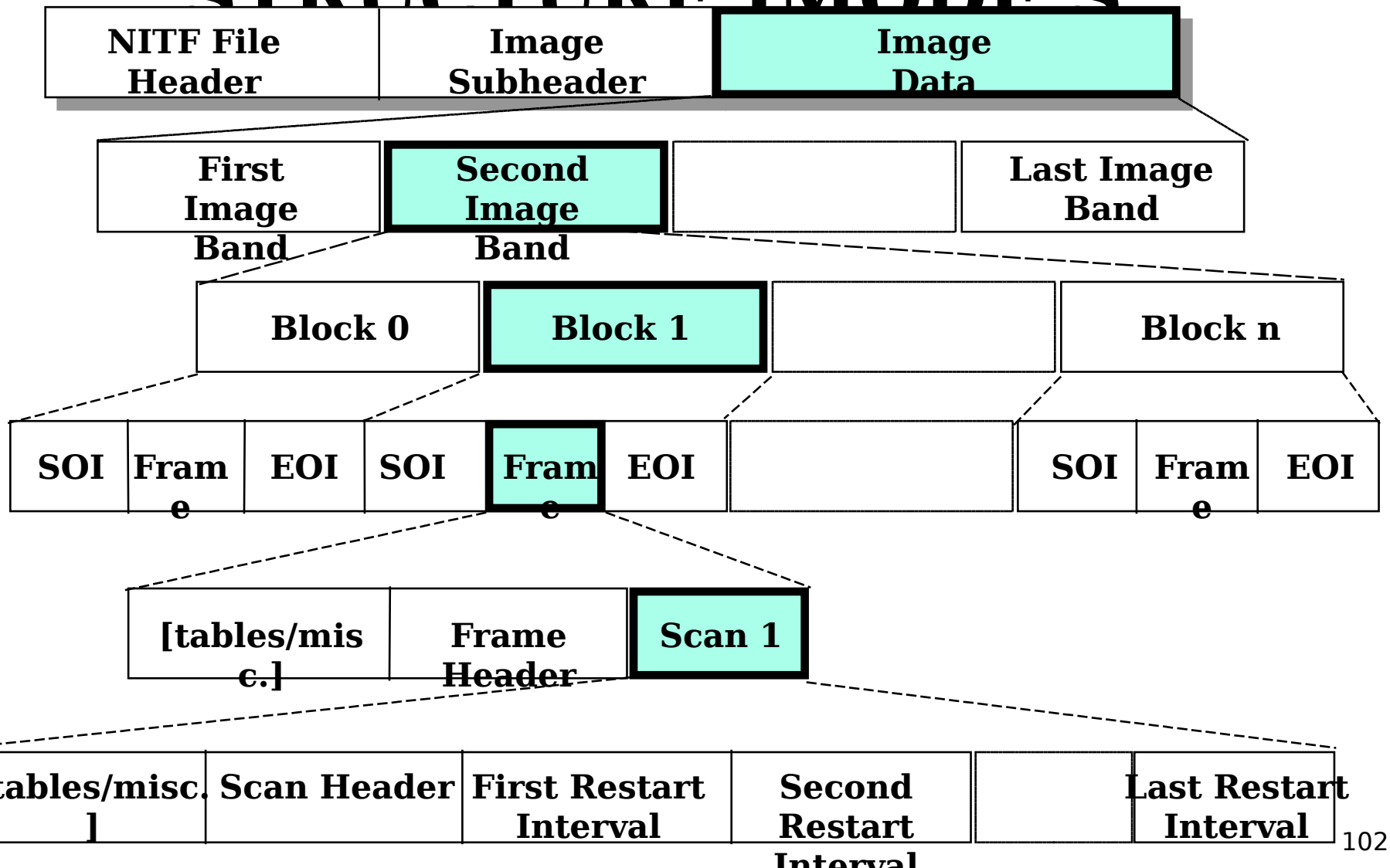


JPEG COMPRESSED NITF MULTIPLE BLOCK FILE STRUCTURE (IMODE B OR P)

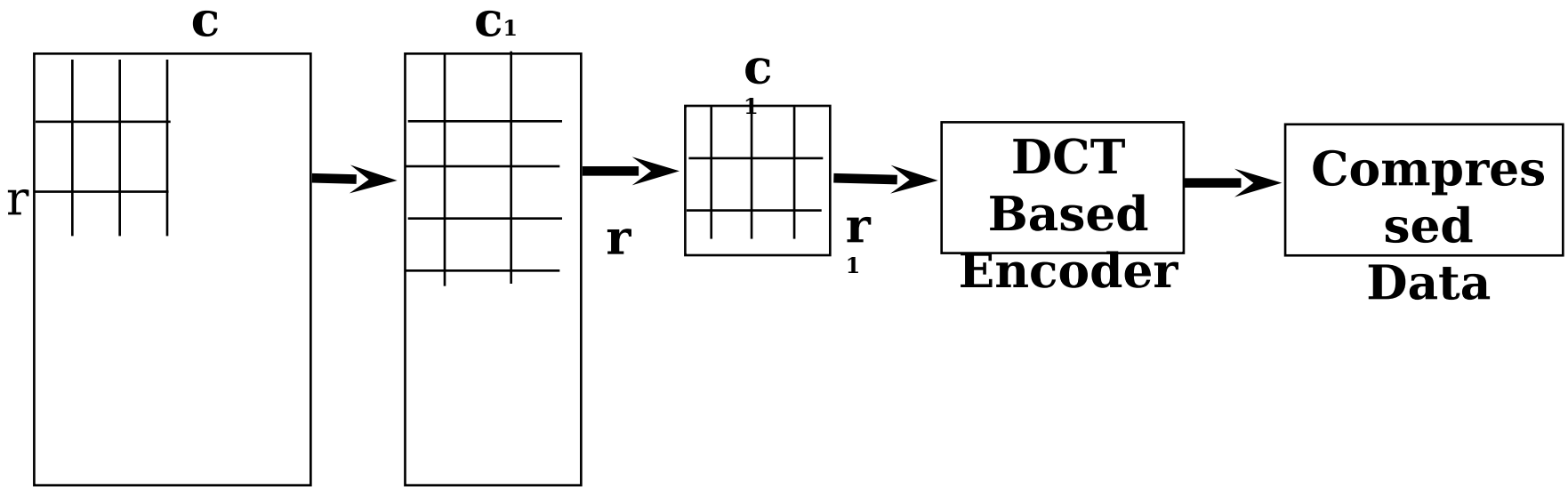


SOI: Start of Image EOI: End of Image

JPEG COMPRESSED NITF MULTIPLE BLOCK FILE STRUCTURE IMODE S

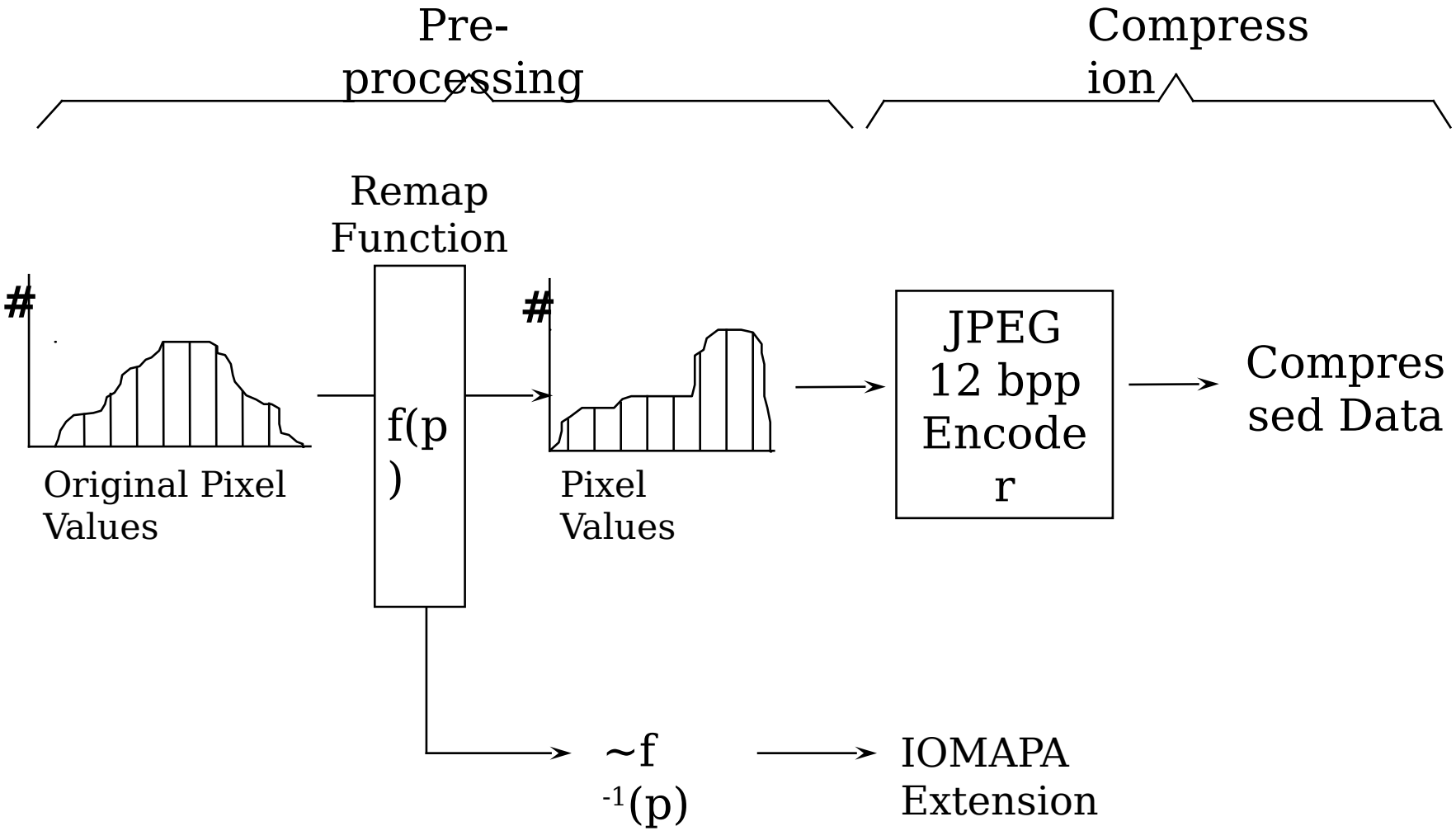


DOWNSAMPLE JPEG

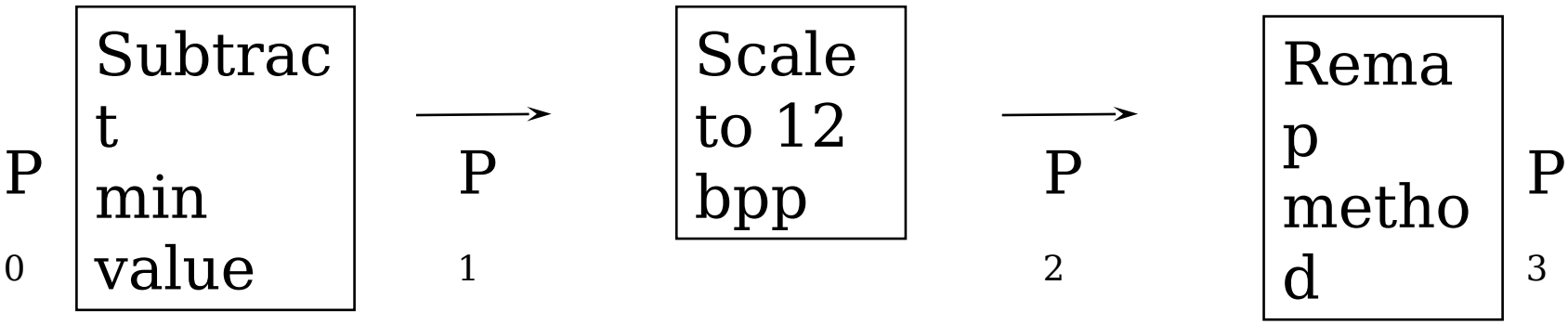


Downsampling Ratio = $\frac{r \times c}{r_1 \times c_1}$

PRE/POST-PROCESSING



REMAPPING FUNCTION



$P_1 = P_0 - P_{min}$

$P_2 = P_1 \times 2^{S_1}$

$(P_2 = P_1 LSL(S_1))$

$P_3 = F_{remap(0, 1, 2, 3)}(P_2)$

Remap methods 0, 1, 2 & 3

LSL = Logical Shift Left

REMAP METHODS

0 - No change, unity function. $P_3 = P_2$

1 - Look-up Table,

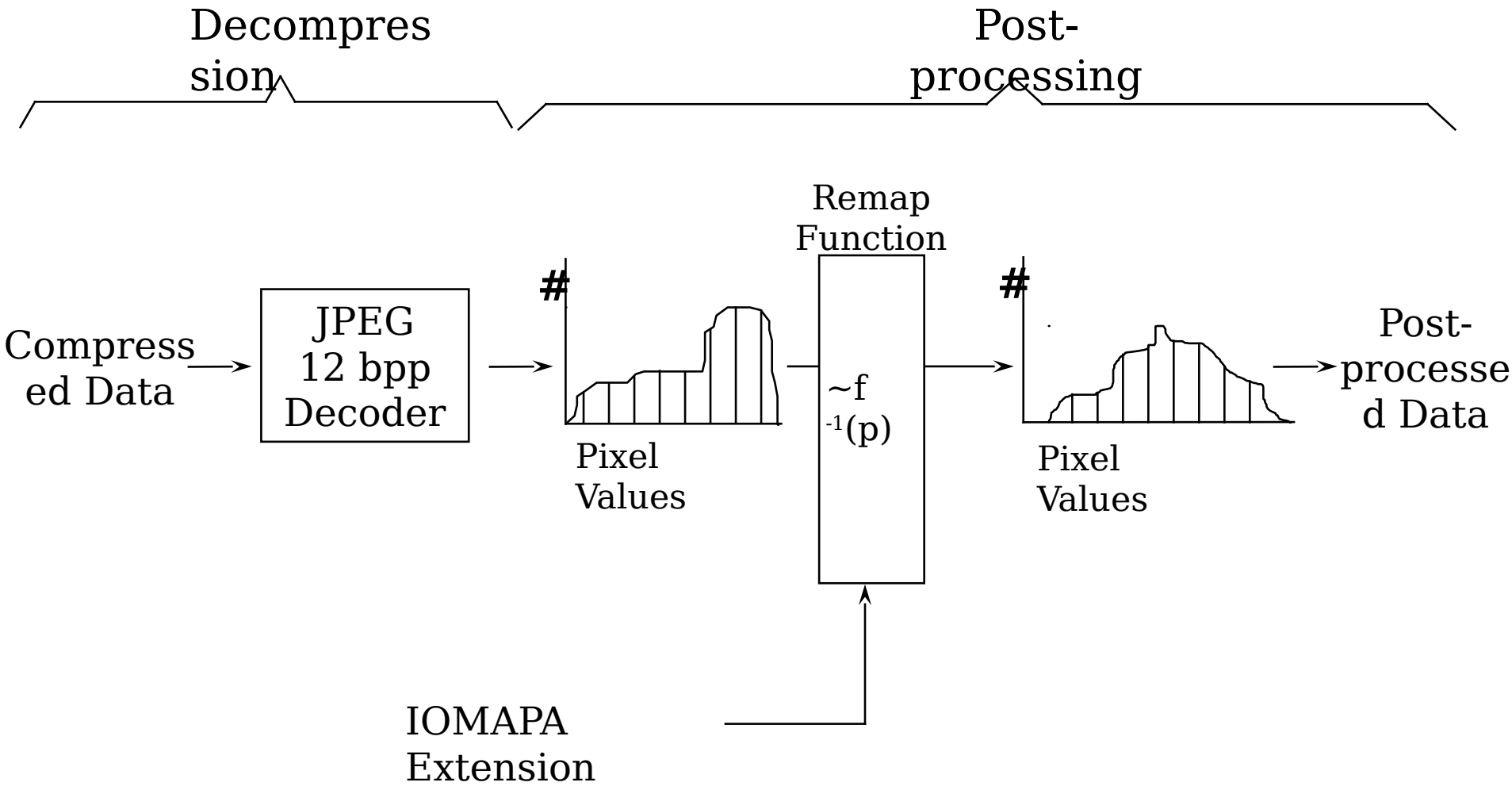
P_2	P_3

2 - Logarithmic function, $P_3 = e^{f(P_2)}$

3 - Polynomial function (up to 5th order),

$$P_3 = b_0 + b_1P_2 + b_2P_2^2 + b_3P_2^3 + b_4P_2^4 + b_5P_2^5$$

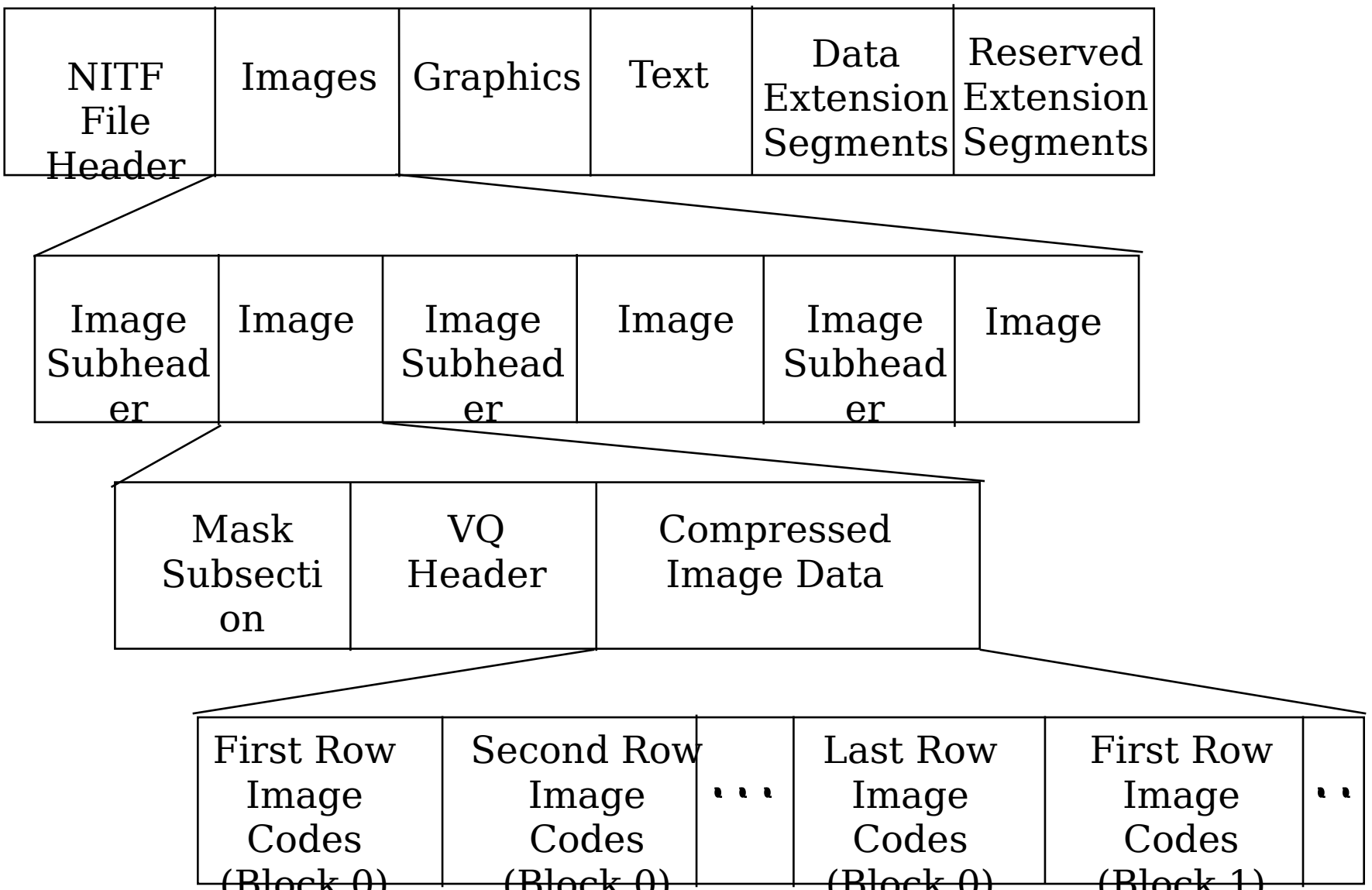
PRE/POST PROCESSING



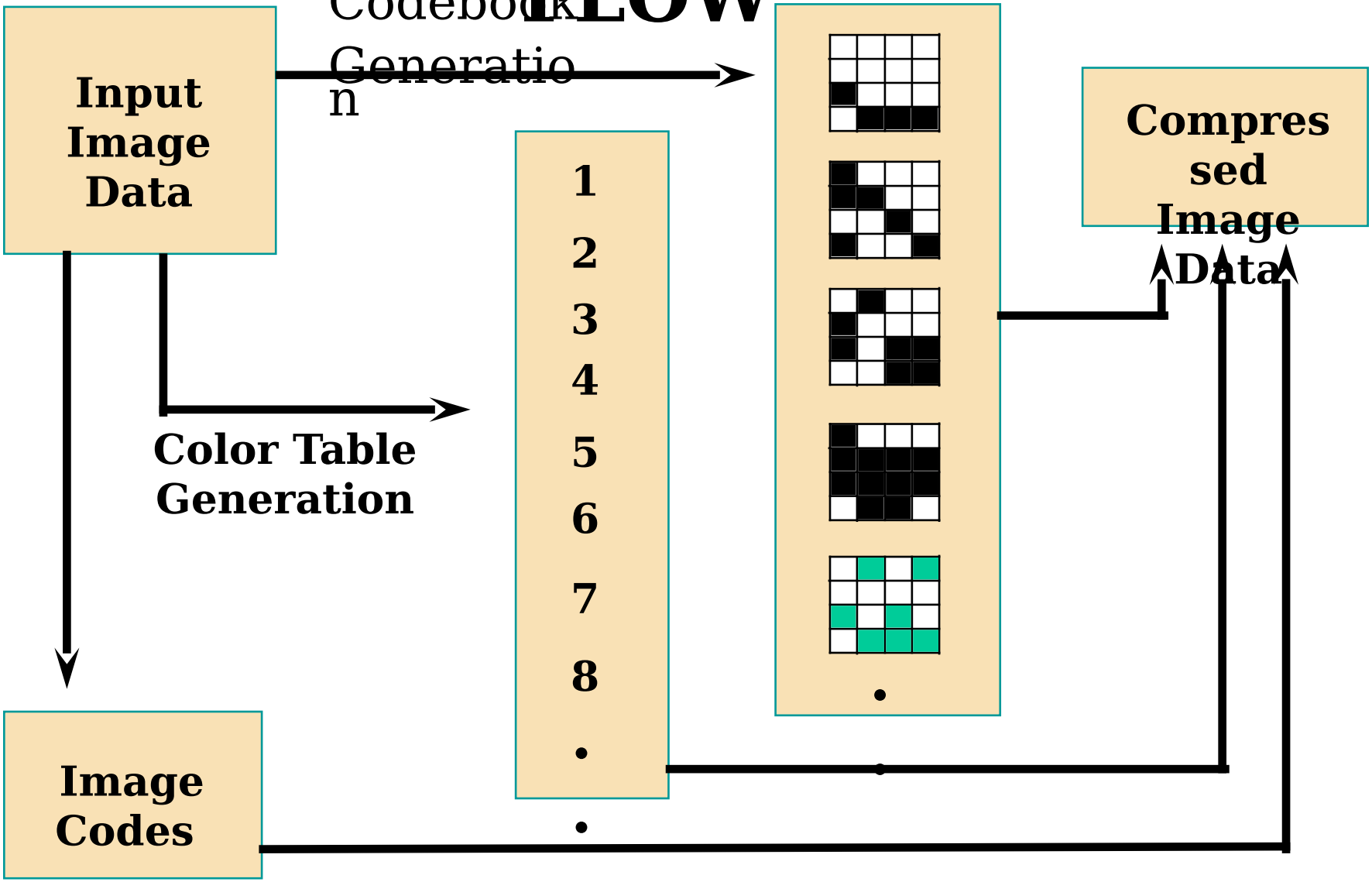
Vector Quantization (VQ)

- **MIL-STD-188-199**
- **ISO/IEC 12087-5 BIIF Annex B**
  - **Compress once, use product many times**
  - **Decompress via simple code book look up process**
  - **High compression (.75 bpp), yet visually lossless**
  - **Used for raster scanned maps, e.g., CADRG**
  - **Used for Controlled Image Base (CIB)**
  - **Unlimited image size; typical is 1536 x 1536**
  - **Suitable for 286 or higher processor**

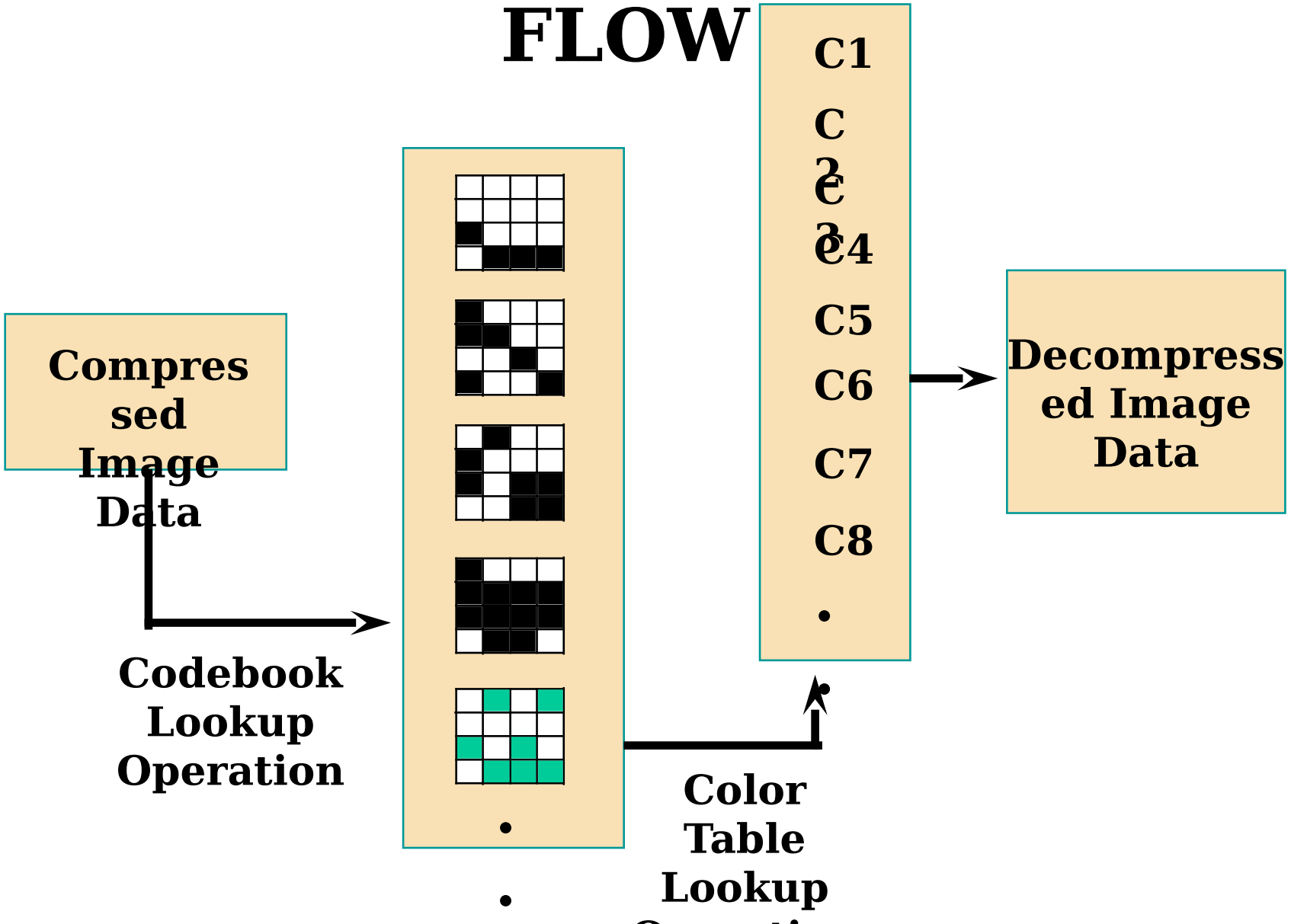
VQ NITF FILE STRUCTURE



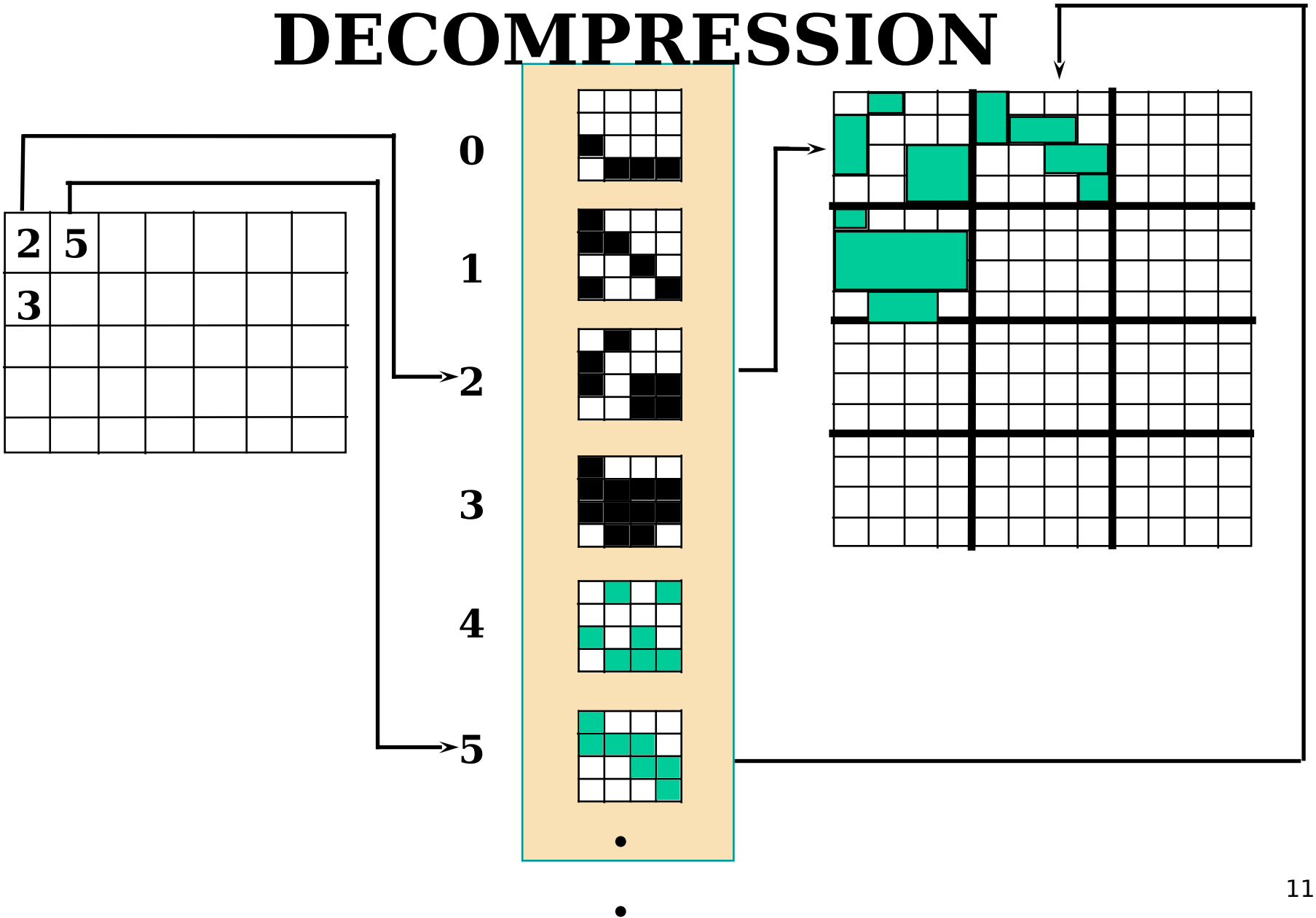
VQ COMPRESSION PROCESS FLOW



DECOMPRESSION PROCESS FLOW



VQ SPATIAL DECOMPRESSION



JPEG 2000

- **ISO/IEC 15444 Part 1**
  - **Wavelet based decomposition by resolution**
  - **Arithmetic entropy encoding**
  - **Pixel precision from 1 to 38 bits per pixel**
  - **Single and multiple bands**
  - **Both numerically lossless and lossy options**
  - **Very scalable**
  - **Many processing options can be done in the compressed data domain (w/o decompression)**
  - **Suitable for today's PCs, Hand-helds, scanners, digital cameras, etc.**

J2K STANDARD STATUS

- The standard only specifies a decoder and a bitstream syntax and is issued in several parts:
  - **Part I:** Specifies the minimum compliant decoder (e.g., a decoder that is expected to satisfy 80% of applications); this International Standard (IS) was approved 12/30/00. This has currently been published by the ISO. It is the basis for the BIIF/J2K Profile.
  - **Part II:** Describes optional features and value added extensions. This IS was approved 1/10/01. We expect to use the multiple component section of this document for the compression of spectral data. It is expected that the BIIF/J2K Profile will be modified to include selected technology from this standard as required.
  - **Part III:** Motion JPEG 2000 with file format from MPEG 4. We expect that this will become part of the BIIF J2K profile at a later date when high resolution motion imagery is more of a requirement.

J2K STANDARD STATUS (CONT'D)

- **Part IV:** Compliance testing procedures. This standard was approved 7/10/02. Compliance test imagery and procedures are very important for the promotion of “compliant” standards and interoperability. This standard will be used to test compliance for the BIIF/J2K profile.
- **Part V:** Reference software: Two versions of reference software (JAVA, C++). The IS was approved. The US has brought concerns that the reference software is currently not fully compliant to the Part 1 standard.
- **Part VI:** Compound document. Being developed to support compound documents (text, graphics, and images) using the Mixed Raster Content (MRC) defined in ISO 16458. These standards are new work items of the JPEG 2000 Committee.

J2K STANDARD STATUS (CONT'D)

- **Part VIII:** Security: JPSEC. Security issues, such as authentication, data integrity, protection of copyright and intellectual property, privacy, conditional access, to mention a few, are among important features in many imaging applications targeted by JPEG 2000. This part of JPEG 2000 standard intends to provide tools and solutions in terms of specifications in order to allow applications to generate, consume, and exchange SECURE JPEG 2000 bitstreams.
- **Part IX:** Interactivity tools, APIs and Protocols:This part would support user interaction with JPEG 2000 images by providing APIs whereby applications could exploit JPEG features and protocols whereby this interaction can occur remotely over networks. Interactivity is a key component in many multimedia applications. Interactivity, in local or remote, often requires rules and syntax for exchange of information. As an example, a thin client may wish to browse through a very large image present on a server without requiring transmission of the whole image, Part 11 of JPEG 2000 intends to provide further specifications to

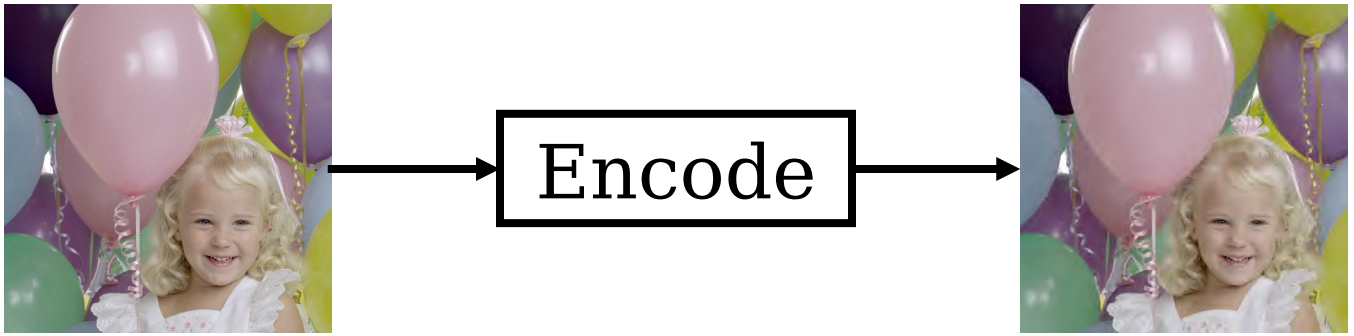
J2K STANDARD STATUS (CONT'D)

- **Part X:** 3-D and floating point data. This part will provide a mechanism for compression and decompression of volume data. JPEG 2000 Part 1 provides encoding and decoding mechanisms for two-dimensional image data. Part 2 provides extension to multiple components via decorrelating transforms. However, there is no provision for encoding across the decorrelated components. There is only two-dimensional encoding among the decorrelated components. Therefore, this part will provide the means for encoding directly three-dimensional set of original or transformed data. The applications are to volume imagery, usually gathered by tomography to create a volume medical, biological or geological images, or to measurement data associated with a three-dimensional grid.

WHAT MAKES JPEG 2000 SPECIAL

- With advances in compression science combined with advances in computers (speed and memory cost) JPEG 2000 has allowed a new compression paradigm to be born
- Advances in compression science
  - Wavelet transform
  - Bit plane arithmetic encoding
  - Embedded bit stream
- Advances in computers
  - Speed of CPU is fast enough to do more computation to achieve the same compression (more complicated compression algorithms)
  - Reduced cost of memory allows to take advantage of greater correlation lengths in an image
- A new paradigm is born

OLD COMPRESSION PARADIGM (JPEG BASELINE)



Encoder choices

color space
quantization
entropy coder
pre-processing

No decoder choices

only one image post-processing

NEW COMPRESSION PARADIGM

Encode choices

Old paradigm choices +
Contone or binary
Tiling
Lossy/lossless

Encode

Decode choices

Image resolution
SNR fidelity
Visual fidelity
Target filesize
Component selection
Lossless/lossy
Region-of-interest

SNR SCALABILITY EXAMPLE

All images have been decompressed from the same bit-stream

RESOLUTION PROGRESSIVE EXAMPLE

All images have been decompressed from the same bit stream. The wavelet decomposition provides a natural resolution

REGION OF INTEREST (ROI) EXAMPLE

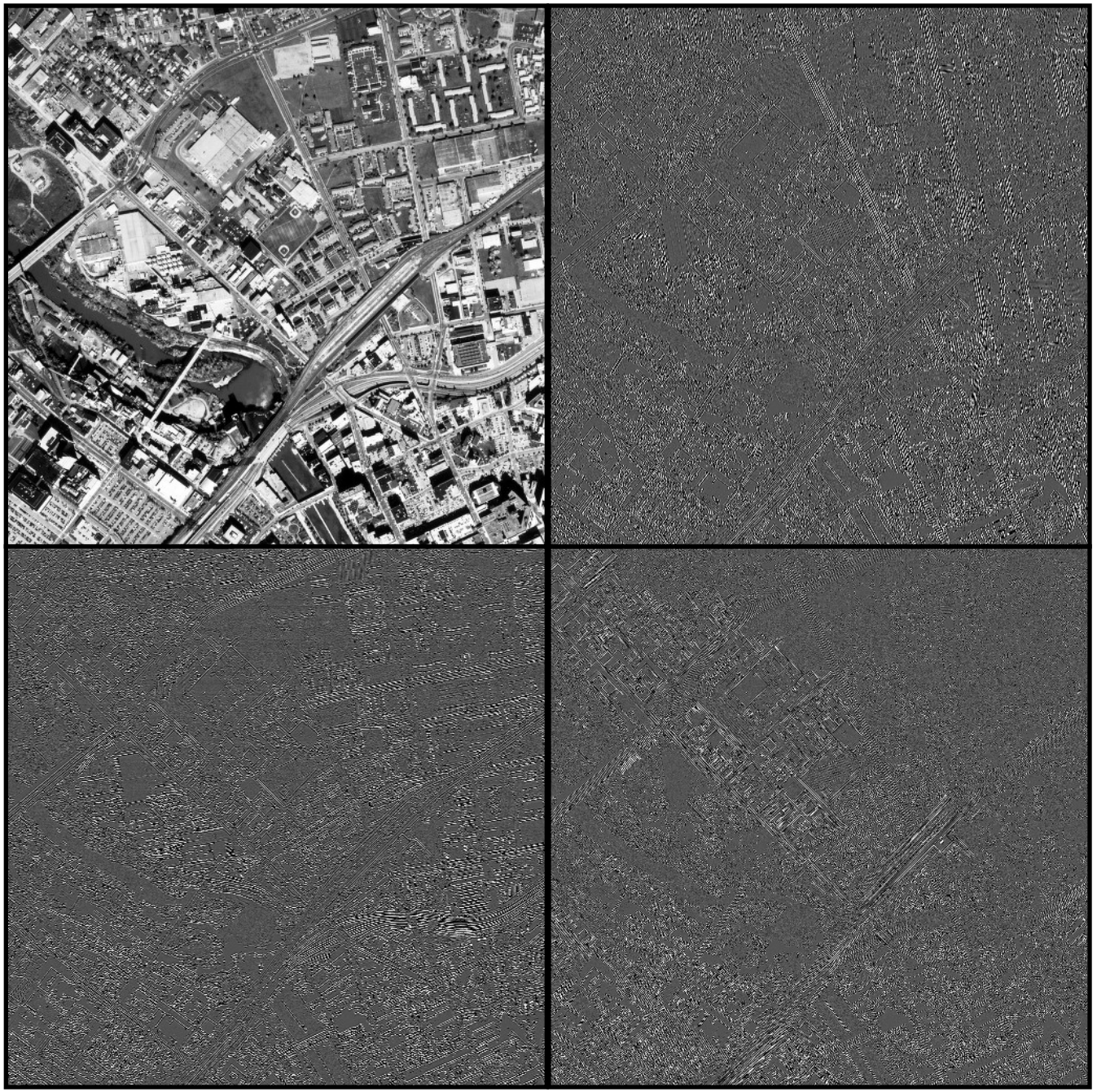
ROI has bit rate of 2.0 bpp

Rest of image has bit rate of 0.0625 bpp

Bit rate for entire image is 0.12 bpp

Original 1024-by-1024

Low-Low

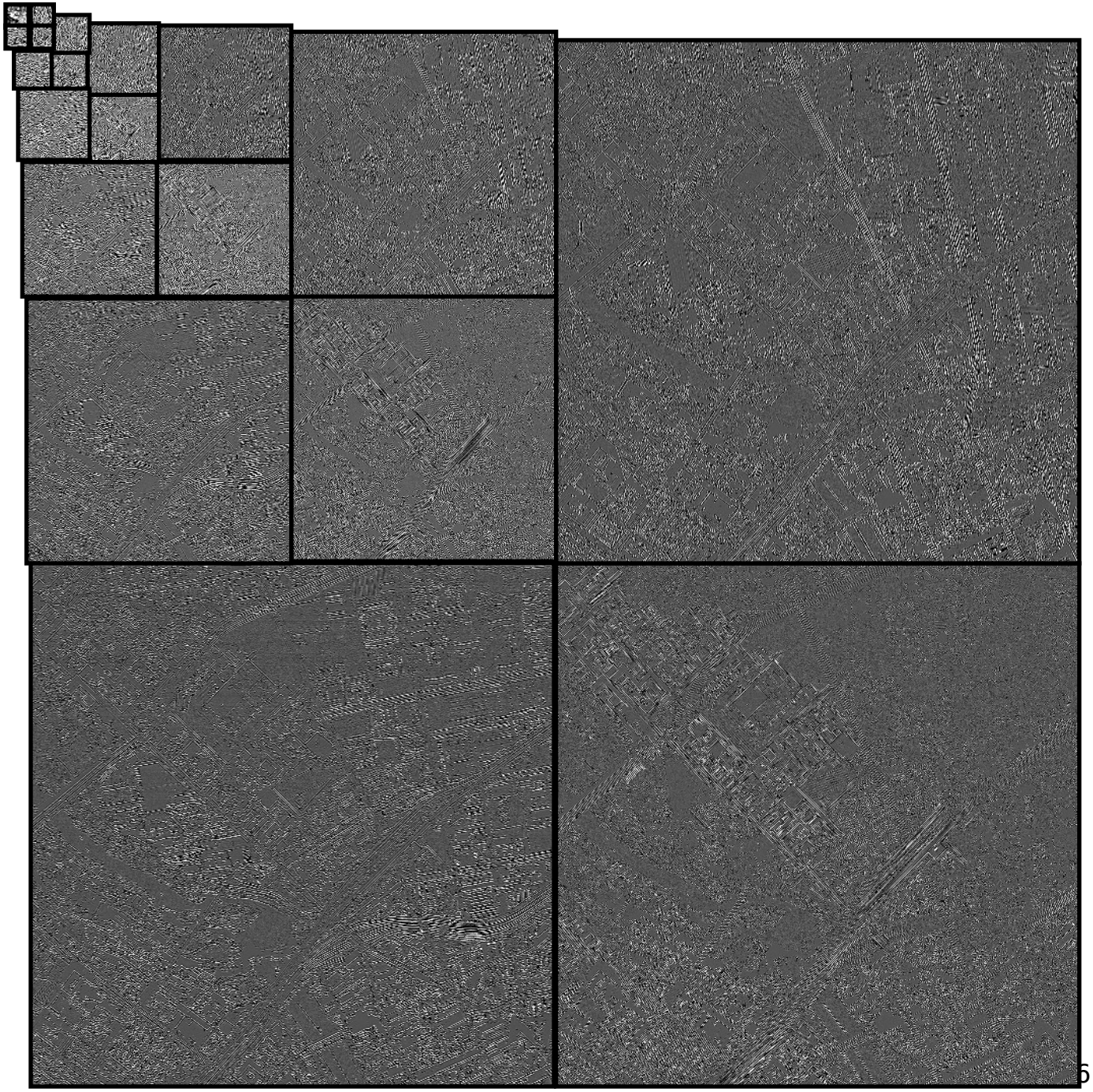


High-Low

Low-High

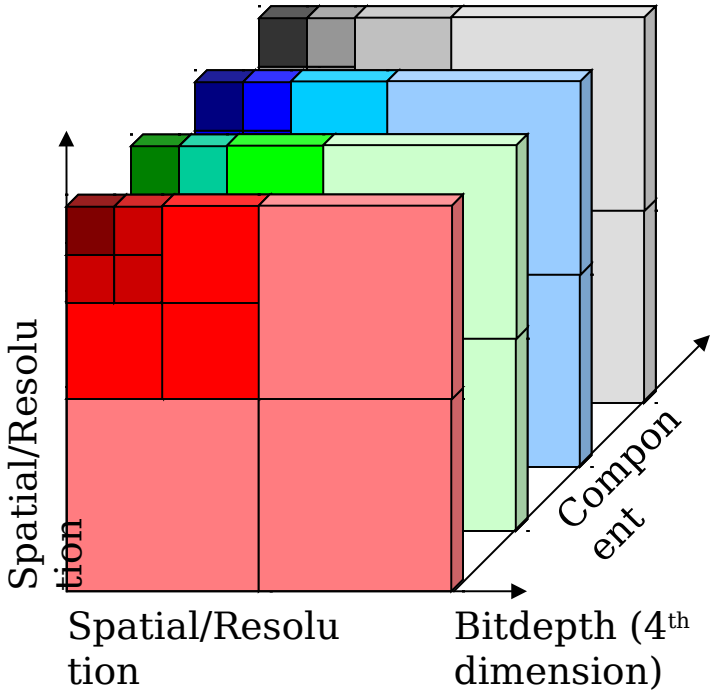
High-High

Wavelet Pyramid decomposition



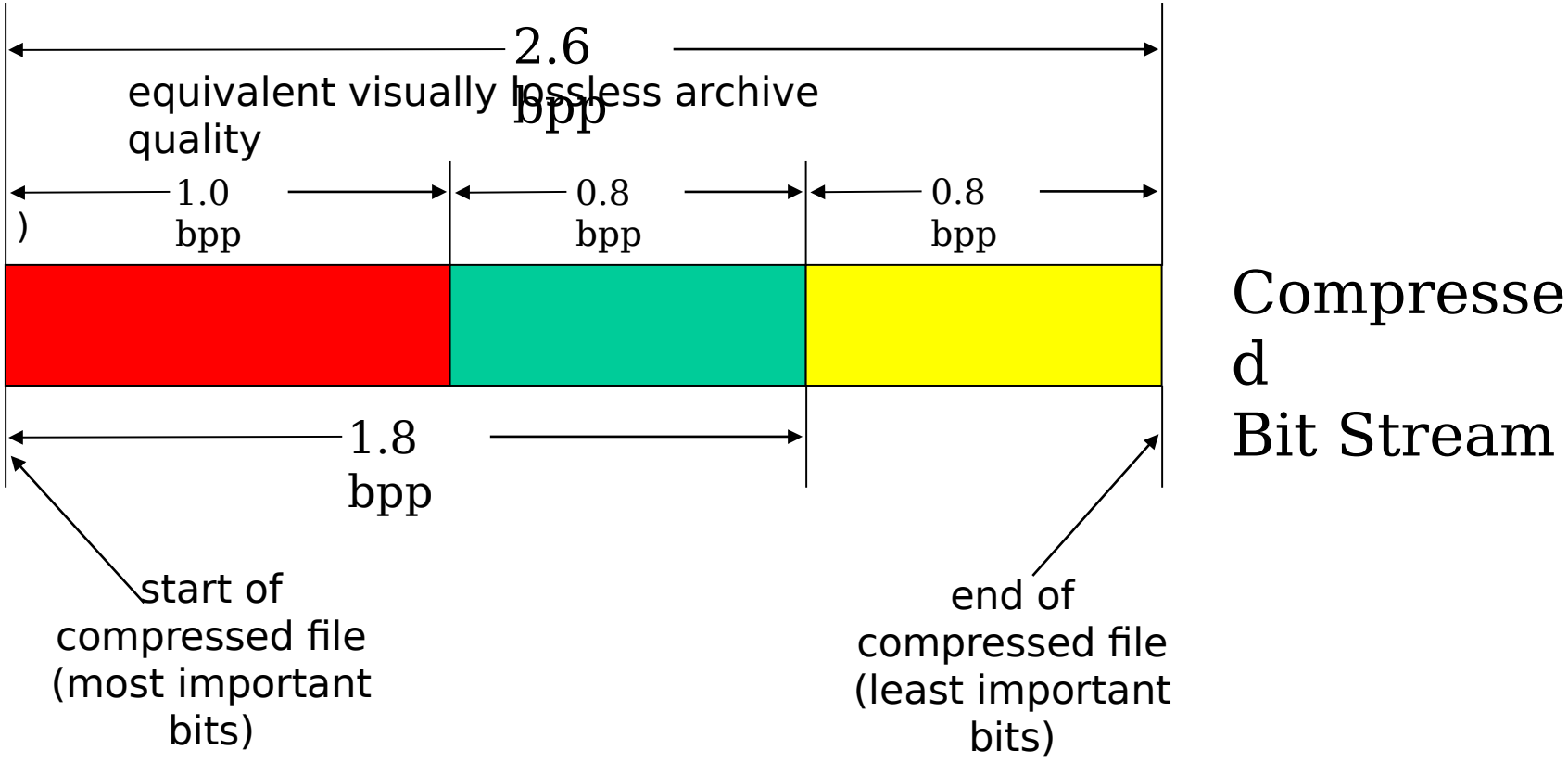
PROGRESSION IN JPEG 2000

- After wavelet processing, we have a four dimensional cube of data
  - Spatial/Resolution (two)
  - Component
  - Bitdepth
- JPEG 2000 allows progression along four dimensions
  - Layer (L)
  - Resolution (R)
  - Component (C)
  - Precinct or position (P)
- These are roughly equivalent as follows
  - Resolution & Precinct ⇔ Spatial/Resolution
  - Component ⇔ Component



Wavelet processed components

EMBEDDED BIT STREAM EXAMPLE

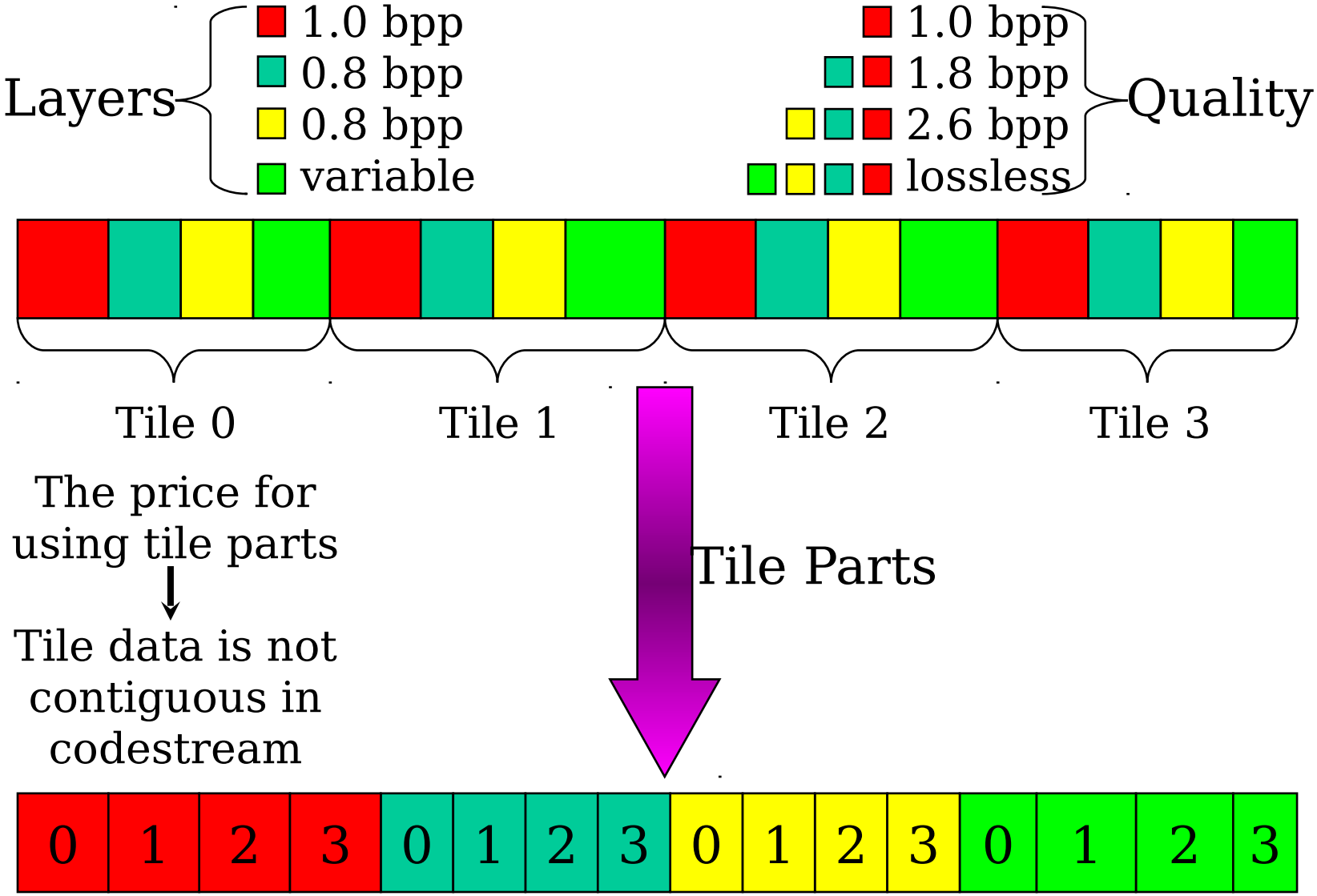


Compress to a very high quality (rate). Then, any quality (rate) less than that can be obtained by truncating compressed bit stream.

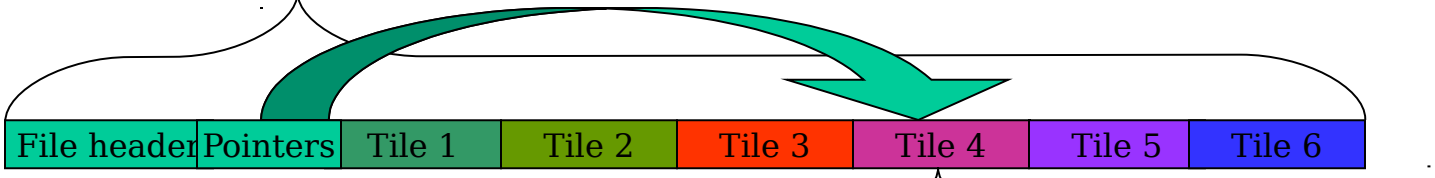
TILES

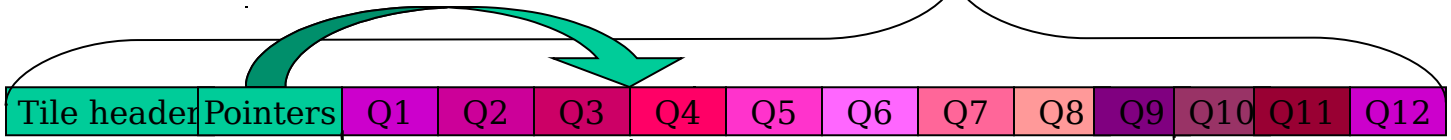
- Tiles are independently coded sub images. Nothing crosses tile boundaries
  - Wavelet
  - Entropy coding
  - Layers
  - Progressions
- Tiles may be broken into tile parts.
  - Tile parts from different tiles can be interspersed in codestream
  - Only mechanism available to achieve “tile progression”
  - Impairs ability to randomly access a tile
- In general, need to parse data out of tiles to achieve a different image quality
  - If all tiles are compressed at 2.0 bpp and you want 1.0 bpp, then need to go into each tile and get the 1.0 bpp

TILE CODESTREAM

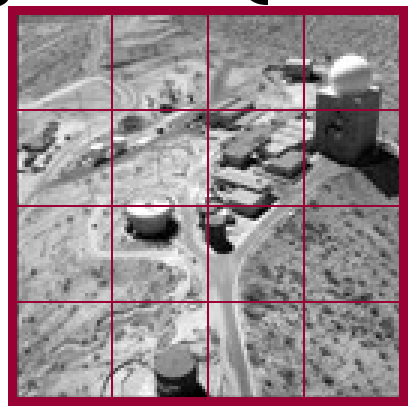


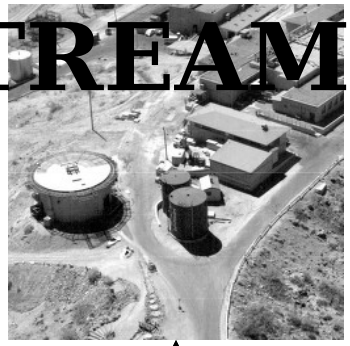
PARSING BITSTREAM

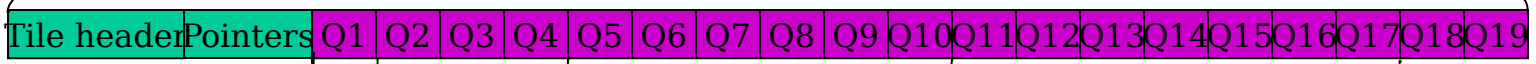




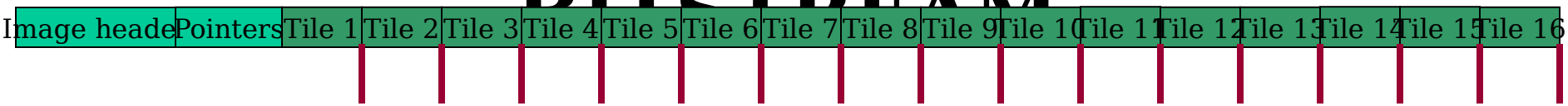
J2K QUALITY PROGRESSIVE BITSTREAM







J2K QUALITY PROGRESSIVE BITSTREAM



Layers 1-3
for all tiles.

J2K QUALITY PROGRESSIVE BITSTREAM

Layers 1-10 for all tiles.

EXAMPLE OF PROGRESSION BY ACCURACY

Original image was 8-bit uncompressed.
All images extracted from a single 2.0 bpp compressed file.

With an embedded, progressively encoded bit stream, simply compress to high quality once and then decode the portion of the bit stream that meets your bandwidth requirements.

J2K QUALITY PROGRESSIVE BITSTREAM

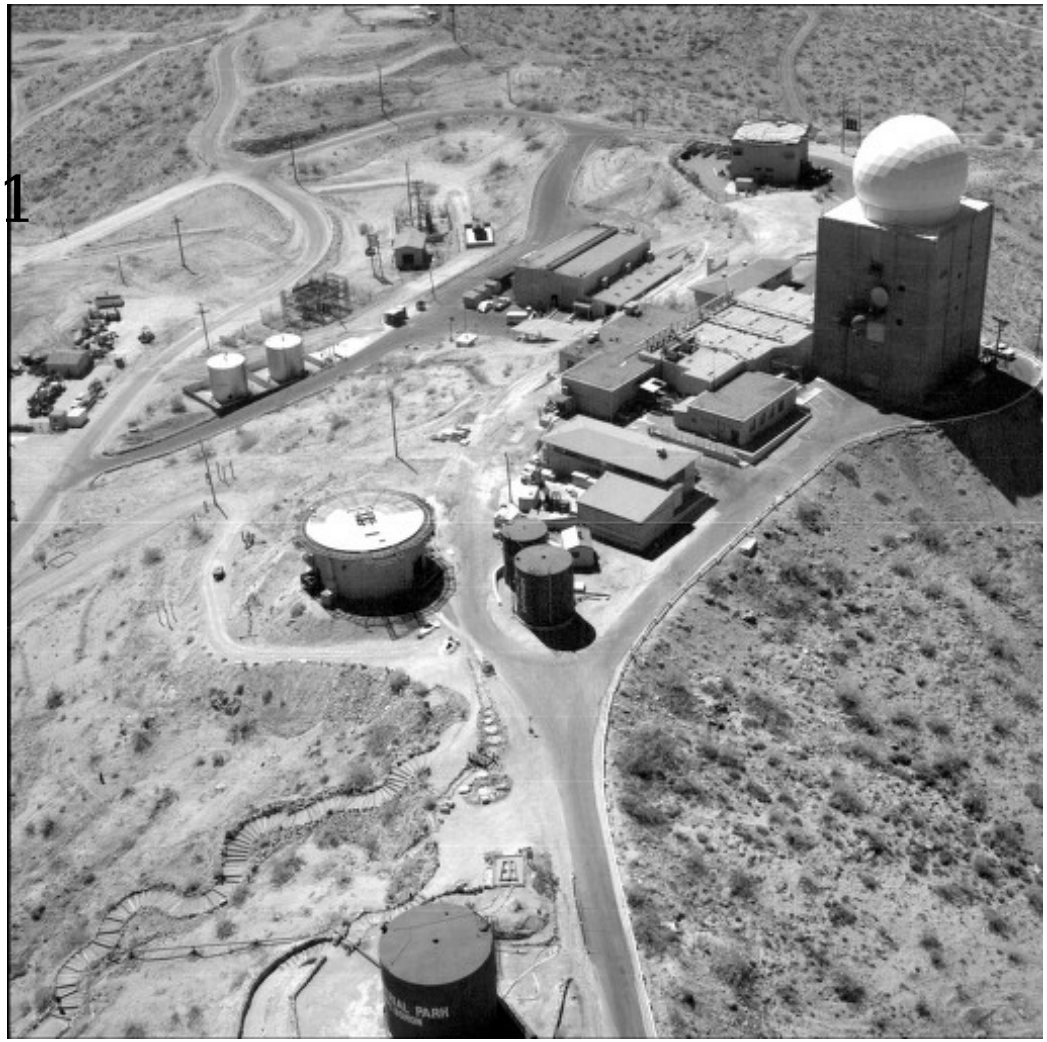
Resolution 3

J2K QUALITY PROGRESSIVE BITSTREAM

Resolution 2

J2K QUALITY PROGRESSIVE BITSTREAM

Resolution 1



EXAMPLES OF PROGRESSION BY RESOLUTION

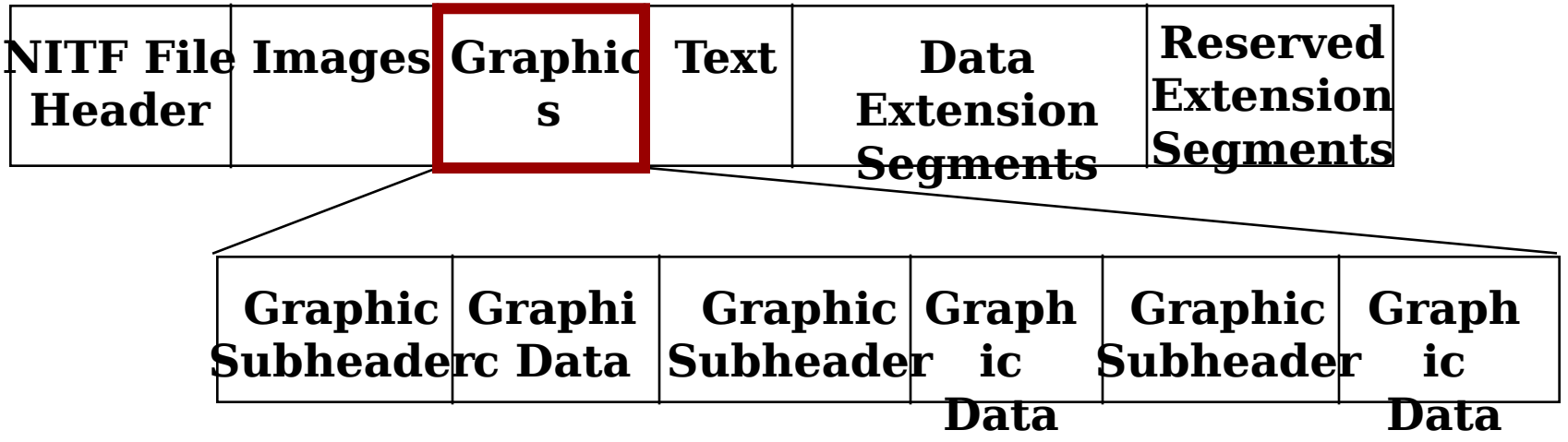
COMPRESSION - FUTURE

- SPECTRAL DATA- Interband correlation
- COMPLEX SAR DATA
- MOTION JPEG 2000
- JPEG 2000 INTERACTIVITY TOOLS
- 3D AND FLOATING POINT DATA

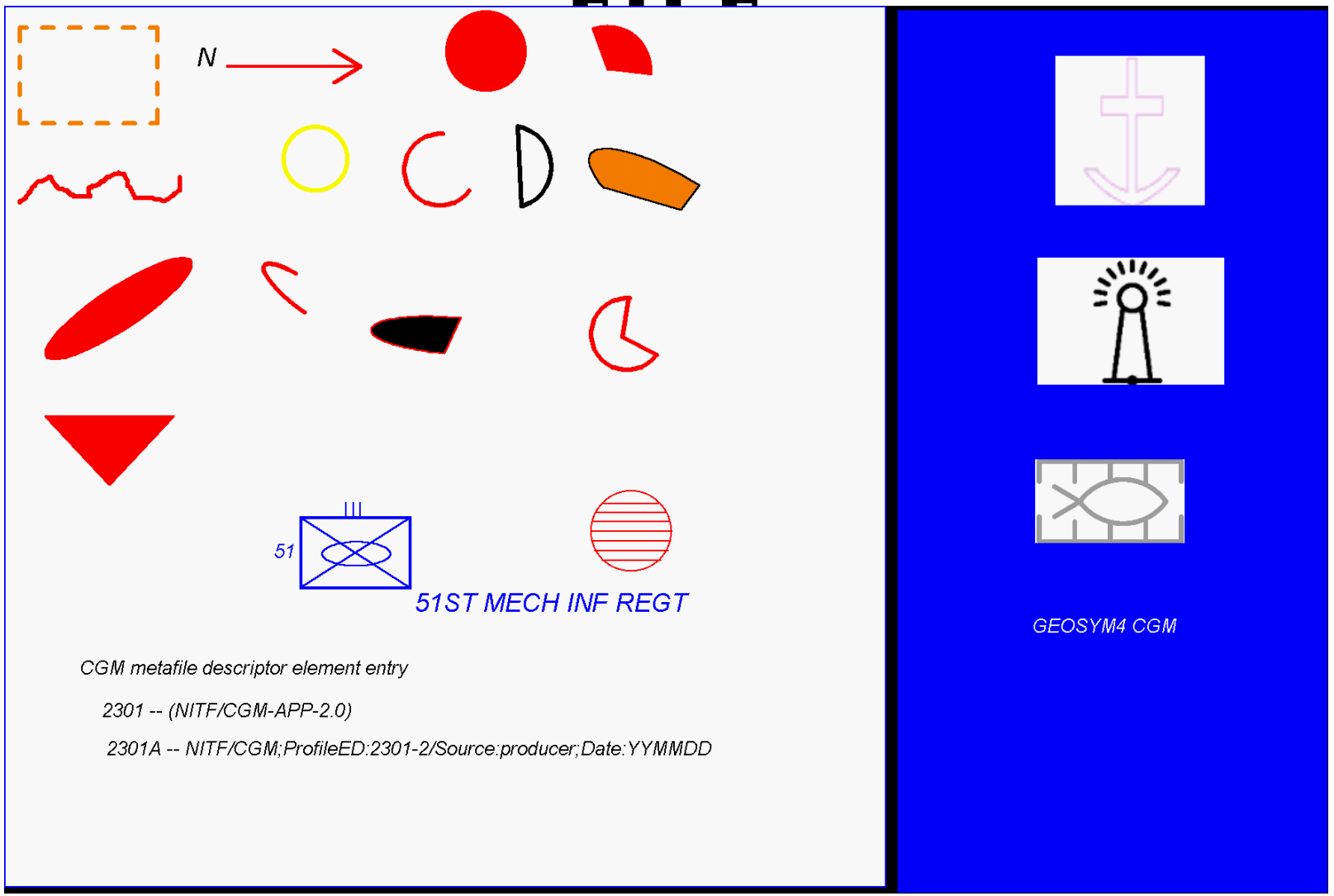
ANNOTATIONS

- Graphics/Symbols
  - CGM
  - Bit-Mapped (Legacy)
- Labels (Legacy)
- Text

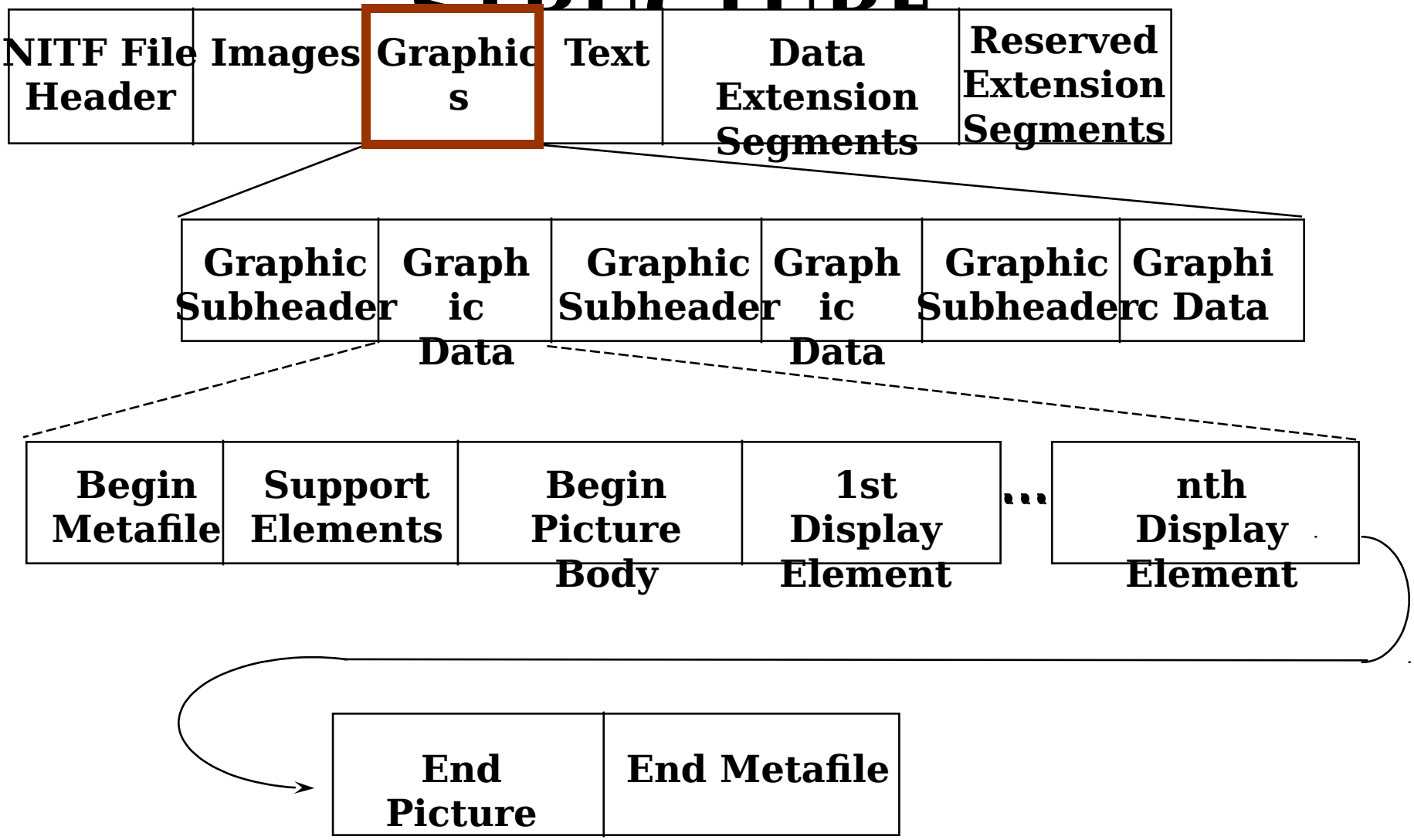
NITF GRAPHIC SEGMENT FILE STRUCTURE



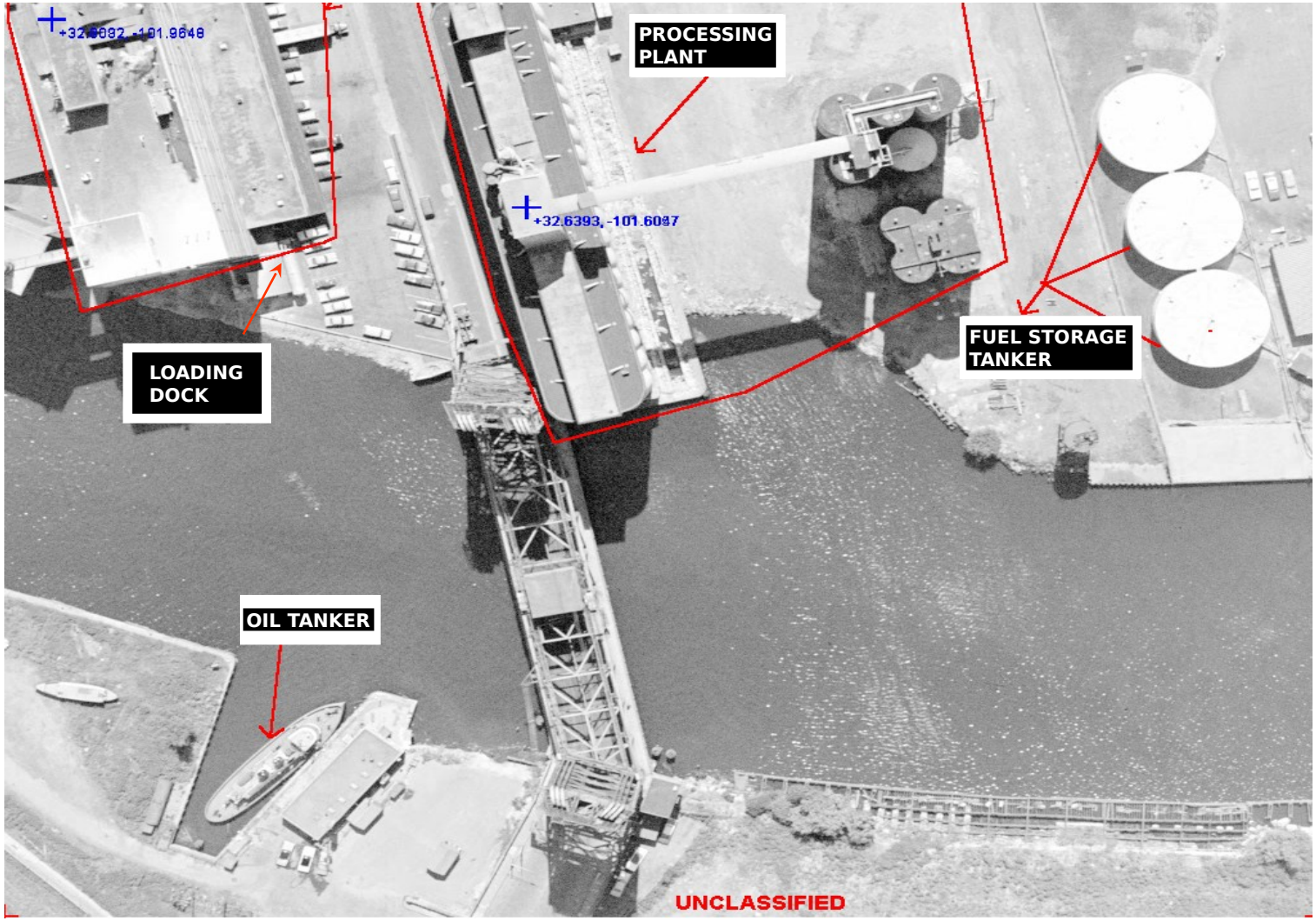
SAMPLE NITF GRAPHIC FILE



CGM NITF FILE STRUCTURE



SAMPLE CGM FILE



CGM ELEMENT FLOW

BEGIN METAFILE
- METAFILE VERSION
- METAFILE ELEMENT LIST
- METAFILE DESCRIPTION
- [FONT LIST]
  - BEGIN PICTURE
    - COLOR SELECTION MODE
    - [EDGE WIDTH SPECIFICATION MODE]
    - [LINE WIDTH SPECIFICATION MODE]
    - VDC EXTENT

    - BEGIN PICTURE BODY
      - [TRANSPARANCY]
      - [AUXILLARY COLOR]
      - [TEXT COLOR]
      - [CHARACTER HEIGHT]
      - [TEXT FONT INDEX]
      - [CHARACTER ORIENTATION]
      - [TEXT]
      - [FILL COLOR]
      - [INTERIOR STYLE]
      - [EDGE VISIBILITY]
      - [EDGE WIDTH
      - [EDGE TYPE]
      - [EDGE COLOR]
      - [POLYGON]
      - [POLYGON SET]
      - [ELLIPSE]
      - [ELLIPTICAL ARC CLOSE]
      - [RECTANGLE]
      - [CIRCLE]
      - [CIRCULAR ARC CENTER CLOSE]
      - [LINE WIDTH]
      - [LINE TYPE]
      - [LINE COLOR]
      - [POLYLINE]
      - [ELLIPTICAL ARC]
      - [CIRCULAR ARC CENTER]

    - END PICTURE

- END METAFILE

POLYGON EXAMPLE

CGM ELEMENT	HEX VALUES
BEGIN METAFILE ("POLYGON")	0x0028 0x0750 0x4F4C 0x5947 0x4F4E
METAFILE VERSION (1)	0x1022 0x0000
METAFILE DESCRIPTION ("POLYGON")	0x1048 0x0750 0x4F4C 0x5497 0x4F4E
METAFILE ELEMENT LIST	0x1166 0x0001 0xFFFF 0x0001
BEGING PICTURE ("POLYGON")	0x0068 0x0750 0x4F4C 0x5947 0x4F4E
COLOR SELECTION MODES (DIRECT =1)	0x2042 0x0001

POLYGON EXAMPLE (CONT'D)

CGM ELEMENT	HEX VALUES
VDC EXTENT	0x20C8 0x0000 0x7FFF 0x7FFF 0x0000
BEGIN PICTURE BODY	0x0080
FILL COLOR (255,255,255)	0x52E3 0xFFFF 0xFF00
INTERIOR STYLE (SOLID = 1)	0x52C2 0x0001
POLYGON (4,5,6,7,8,9)	0x40FF 0x000C 0x0004 0x0005 0x0006 0x0007 0x0008 0x0009
END PICTURE	0x00A0
END METAFILE	0x0040

TEXT EXAMPLE

TEXT ELEMENT	HEX VALUES
BEGIN METAFILE (“TEXT”)	0x0025 0x0454 0x4558 0x5400
METAFILE VERSION (1)	0x1022 0x0001
METAFILE DESCRIPTION (“TEXT”)	0x1045 0x0454 0x4558 0x5400
METAFILE ELEMENT LIST	0x1166 0x0001 0xFFFF 0x0001
FONT LIST (“Helvetica,” “Courier”)	0x11B2 0x0948 0x656C 0x7665 0x7469 0x6361 0x0743 0x6F75 0x7269 0x6572

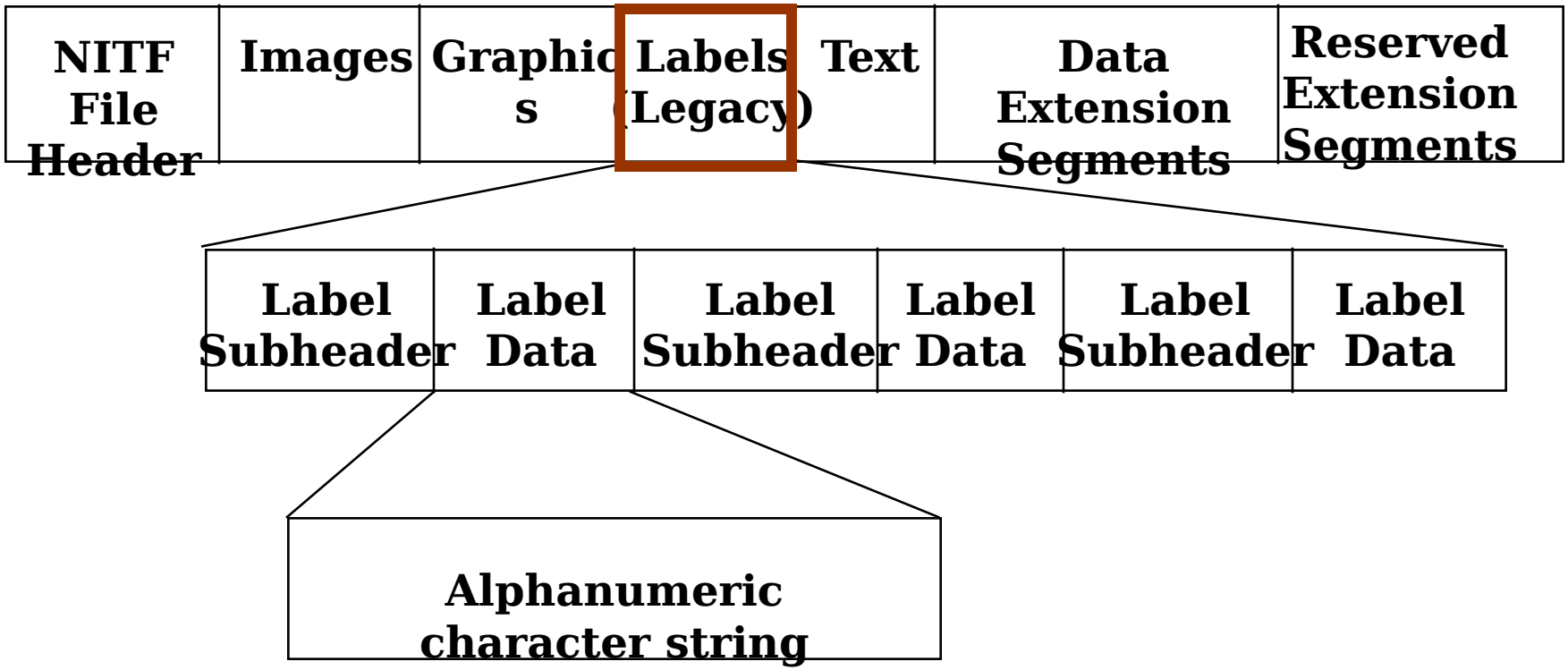
TEXT EXAMPLE (CONT'D)

TEXT ELEMENT	HEX VALUES
BEGIN PICTURE ("TEXT")	0x0065 0x0454 0x4558 0x5400
COLOR SELECTION MODES (DIRECT = 1)	0x2042 0x0001
VTC EXTENT	0x20C8 0x0000 0x7FFF 0x7FFF 0x0000
BEGIN PICTURE BODY	0x0080
TEXT COLOR (25,255,255)	0x51C3 0xFFFF 0xFF00
CHARACTER HEIGHT (14)	0x51E2 0x000E
TEXT FONT INDEX (2 = Courier)	0x5142 0x0002

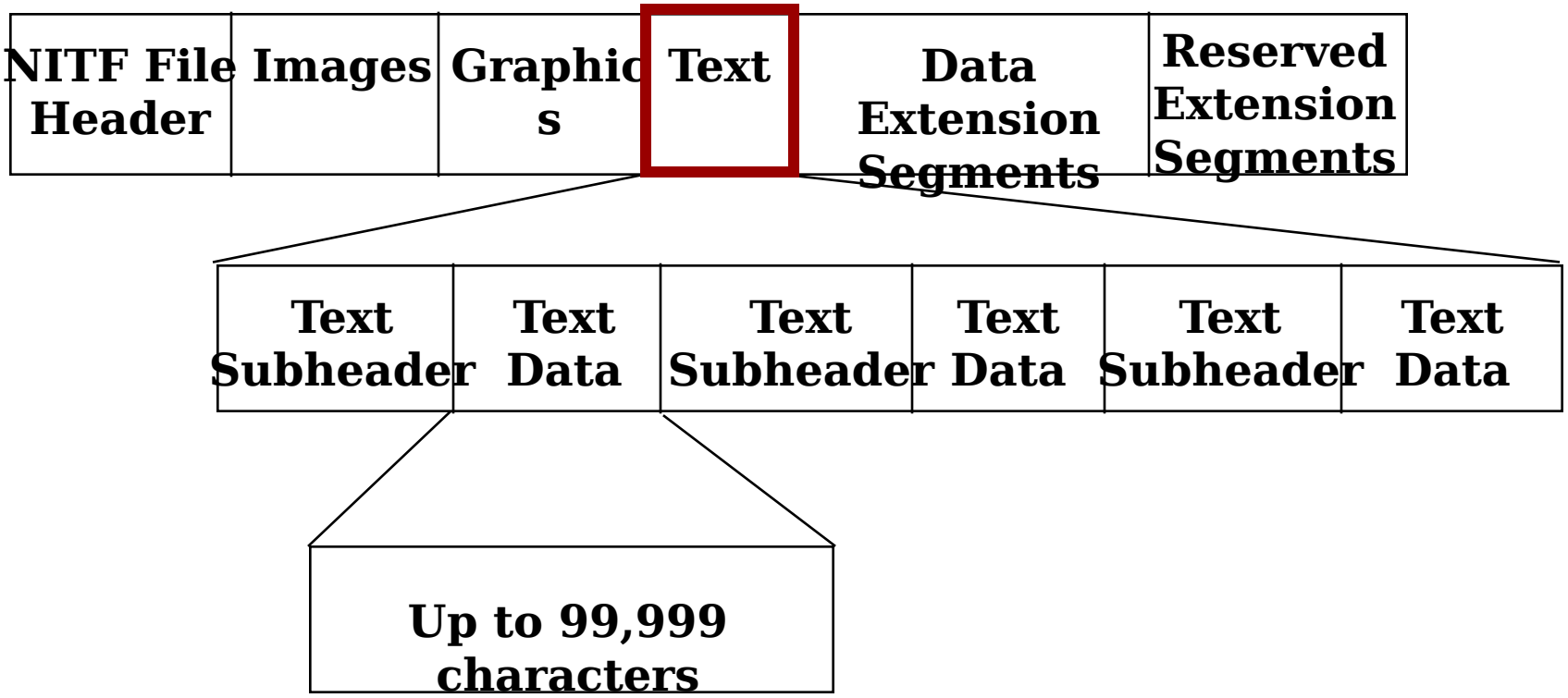
TEXT EXAMPLE (CONT'D)

TEXT ELEMENT	HEX VALUES
CHARACTER ORIENTATION	0x5208 0x0000 0xFFFF 0x0001 0x0000
TEXT (10,20,1,4, "test")	0x408B 0x000A 0x0014 0x0001 0x0474 0x6573 0x7400
END PICTURE	0x00A0
END METAFILE	0x0040

NITF LABEL SEGMENT FILE STRUCTURE (Legacy)



NITF TEXT SEGMENT FILE STRUCTURE



SUPPORTED TEXT TYPES

Text Formats:

- **STA** - The NITF STA format is composed of : line feed (0x0A), form feed (0x0C), carriage return(0x0D), and space (0x20) through tilde (0x7E) (Basic Latin Character Set)
- **MTF** - The NITF MTF format is composed of: line feed (0x0A), form feed (0x0C), and space (0x20) through tilde (0x7E). Line ending is identified by either 69 char count or double solidus \\ (0x2F)
- **UT1** and **U8S** (Single octet encoded and UTF-8 encoded)
  - The NITF UT1 and U8S formats are composed of:
    line feed (0x0A), form feed (0x0C), carriage return (0x0D), space (0x20) through tilde (0x7E), and no break space (0xA0) through

EXTENSIONS

- Types
  - Tagged Record Extension (TRE)
    - Controlled Extension (CE)
    - Registered Extension (RE)
  - Data Extension Segment (DES)
  - Reserved Extension Segment (RES)
- Structure and Placement
- TRE Overflow
- Configuration Management
- Prominent Groups of Extensions

TRE STRUCTURE

FIELD	NAME	SIZE	VALUE RANGE	TYPE
RETAG or CETAG	Unique extension type identifier	6	Alphanumeric (Value registered with the NTB)	R
REL or CEL	Length of REDATA field	5	1 - 99988	R
REDATA or CEDATA	User-defined data	*	User-defined	R

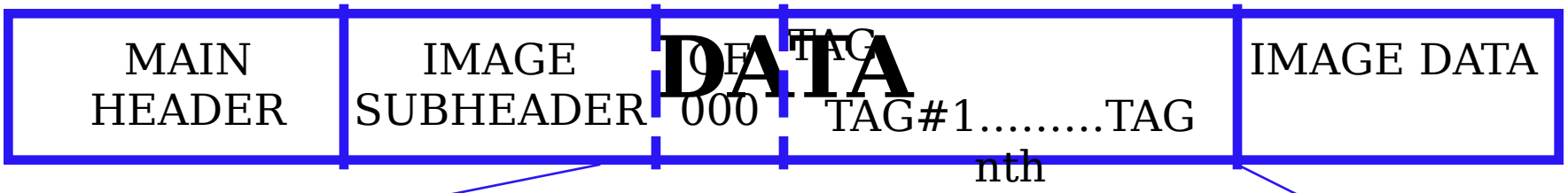
* As indicated in REL or CEL

TRE PLACEMENT

TRE may be placed in:

- File Header (2 x 99,999 bytes available)
  - UDHD (User Defined Header Data)
  - XHD (Extended Header Data)
- Image Subheader (2 x 99,999 bytes available)
  - UDID (User Defined Image Data)
  - IXSHD (Image Extended Subheader Data)
- Symbol/Graphic subheader (1 x 99,999 bytes available)
  - SXSHD (Symbol Extended Subheader Data)
- Text Subheader (1 x 99,999 bytes available)

CE & RE TAG EXTENSION



FIELD NAME	FIELD VALUE	BYTE LENGTH
UDIDL	00000	5
IXSHDL	00167	5
IXSOFL	000	3
CETAG	PIATGA	6
CEL	00096	5
CEDATA	TAG INFO	96
CETAG	PIAEVA	6
CEL	00046	5
CEDATA	TAG INFO	46

***n for this case is two (2 tags)**

DES/RES STRUCTURE

FIELD	NAME	SIZE	VALUE RANGE	TYPE
DE	File Part Type	2	DE	R
DESTAG	Unique DES type identifier	25	Alphanumeric	R
DESVER	Version of the data field definition	2	1 to 99	R
DESSG	Security group	†	(See Table XVIII)	R
DESOFLOW	Overflowed header type	6	Alphanumeric	C
DESITEM	Data item overflowed	3	0 to 999	C
DESSHL	Length of user-defined subheader fields	4	0-9999	R
DESSHF	User-defined subheader fields	*	Alphanumeric	C
DESDATA	User-defined data field	**	User defined	R

RES structure uses the same field structure (i.e., RE, RESTAG, RESVER, RESSG, RESOFLOW, RESITEM, RESSHL, RESSHF, and RESDATA).

DES & RES EXTENSION SEGMENTS

- DES (NITF 2.0)
  - Controlled Extensions (Overflow CEs)
  - Registered Extensions (Overflow REs)

- DES (NITF 2.1)
  - TRE_OVERFLOW
  - STREAMING_FILE_HEADER

  (Defined, but not currently being used.)
  - Other DES specifications are forthcoming

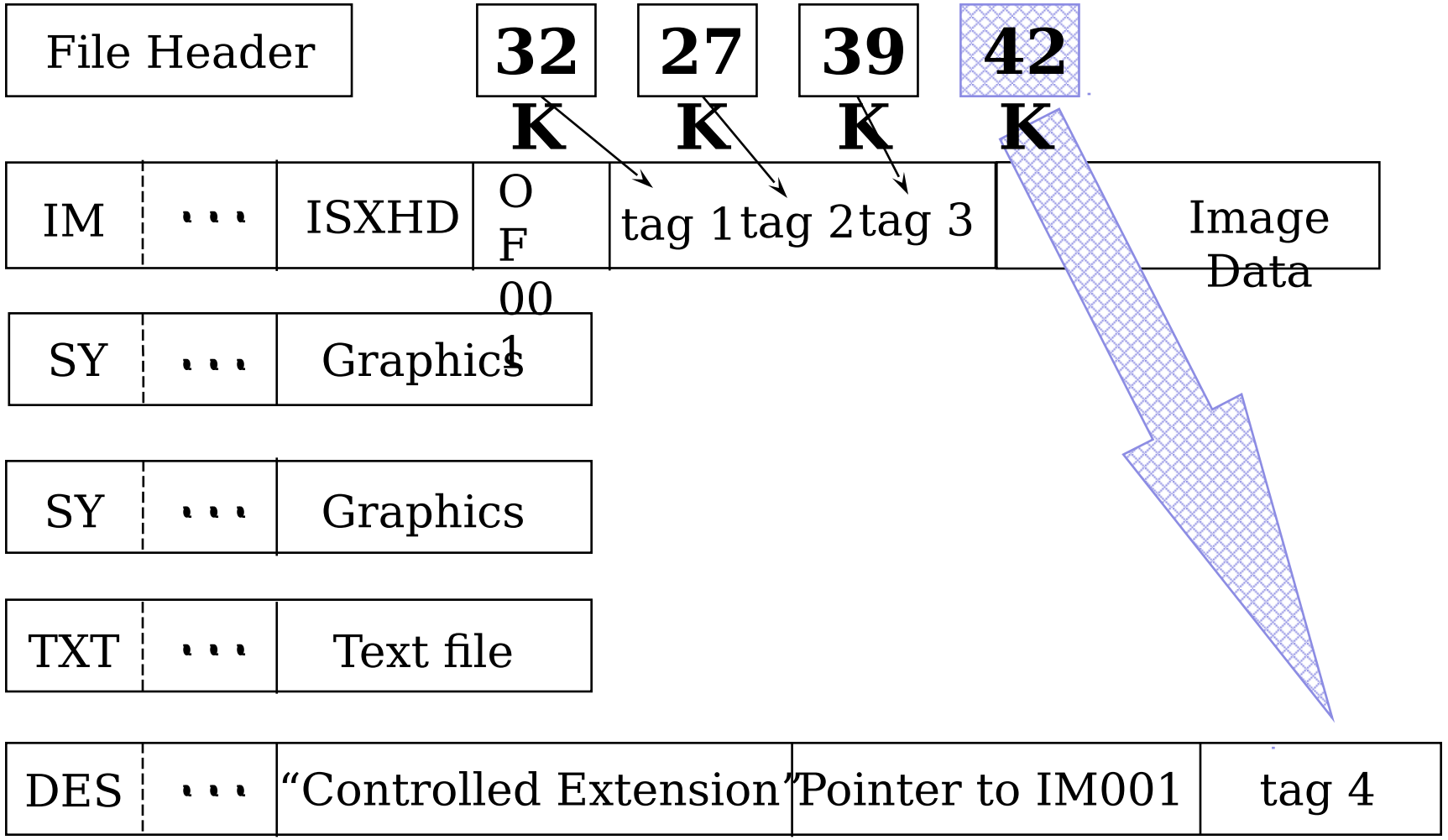
- RES (Future)

TRE_OVERFLOW DES STRUCTURE

Example

FIELD	VALUE	SIZE
DE	DE	2
DESID	TRE_OVERFLOW	25
DESVER	01	2
DECLAS	T, S, C, R, or U	1
SECURITY FIELDS		166
DESOFLW	UDHD, UDID, XHD, IXSHD, SXSHD, TXSHD	6
DESITEM	000 to 999	3
DESSHL	0000	4
DESDATA	User-defined TREs with no intervening octets	?

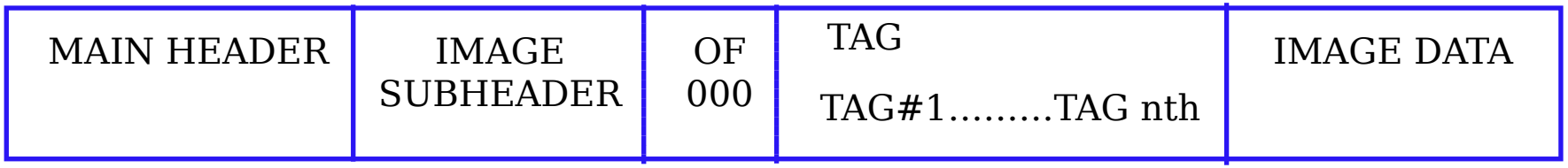
CE OR RE WITH DES OVERFLOW TAGS



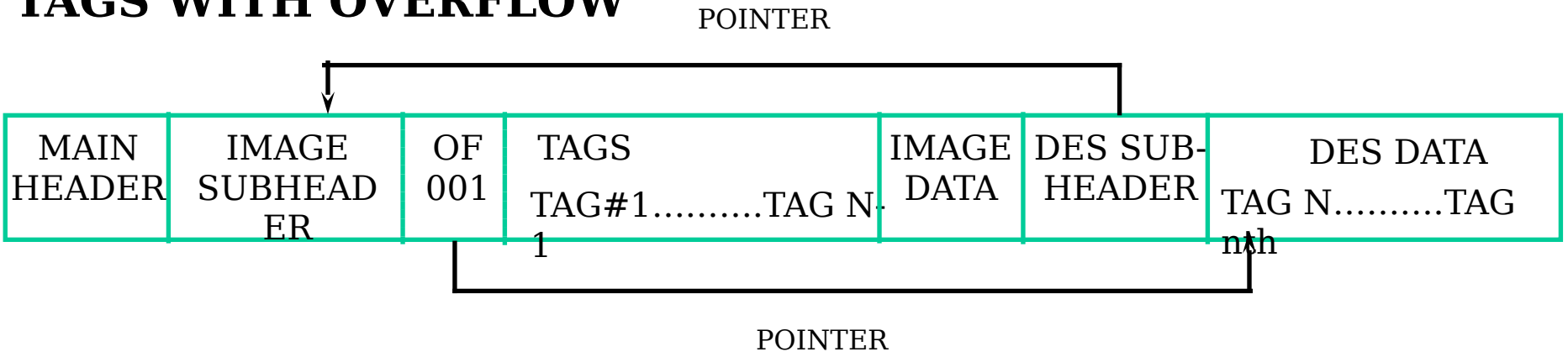
OVERFLOW

NO TAGS

TAGS NO OVERFLOW



TAGS WITH OVERFLOW



CONTROLLED TAG GENERAL STRUCTURE W/OVERFLOW

FIELD NAME	FIELD VALUE	BYTES
FHDR	NITF02.00	9
CLEVEL	06	2
ETC.	**ETC.**	**ETC.**
FL	0000805075764	12
HL	000417	6
L1001	0084934656	10
NUMS	000	3
NUML	000	3
NUMT	000	3
NUM DES	001	3
LDSH001	0249	4
LD001	000042000	9
NUM RES	000	3
UDHDL	00000	5
XHDL	00000	5
IM	IM	2
ETC.	**ETC.**	**ETC.**
IMAG	1.0	4
UDIDL	00000	5
IXSHDL	98003	5
IXSOFL	001	3
IXSHD	98000	TAG DATA
IMAGE DATA		
DE	DE	2
DES TAG	CONTROLLED EXTENSIONS	
25		
ETC.	**ETC.**	**ETC.**
DES FLOW	IXSHD	6
DES ITEM	001	3
DES SHL	0000	4
DATA EXTENSIONS SEG 42000		

MAIN NITF HEADER

IMAGE SUBHEADER

DES SUBHEADER

***Capacity of IXSHD is 99,999 BYTES. The first three tags fit into the IXSHD while TAG 4 is overflow in the Data Extension Seg.**

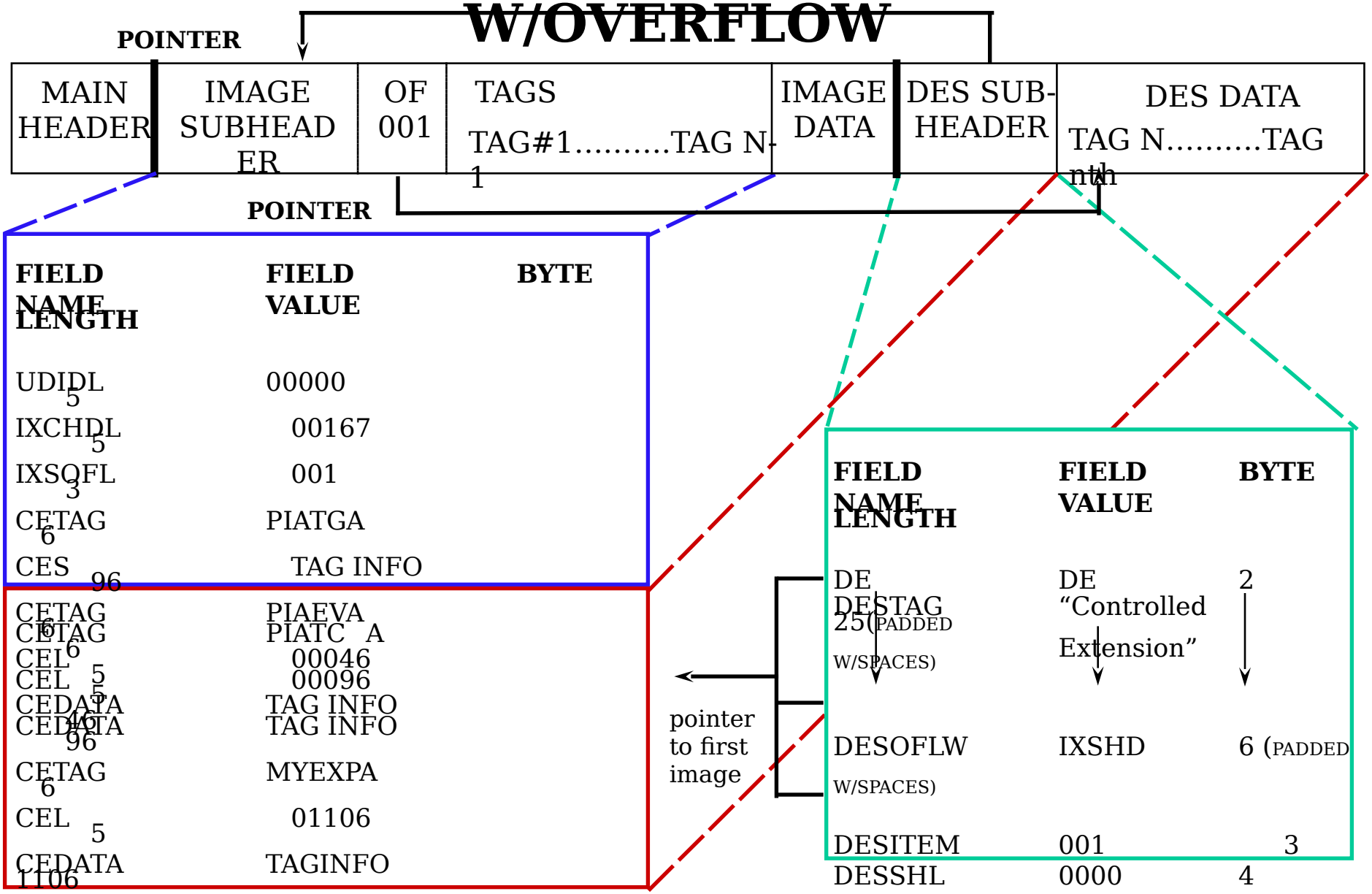
TAG 1 = 32,000 BYTES

TAG 2 = 27,000 BYTES

TAG 3 = 39,000 BYTES

TAG 4 = 42,000 BYTES

GENERAL STRUCTURE OF TAG DATA W/OVERFLOW



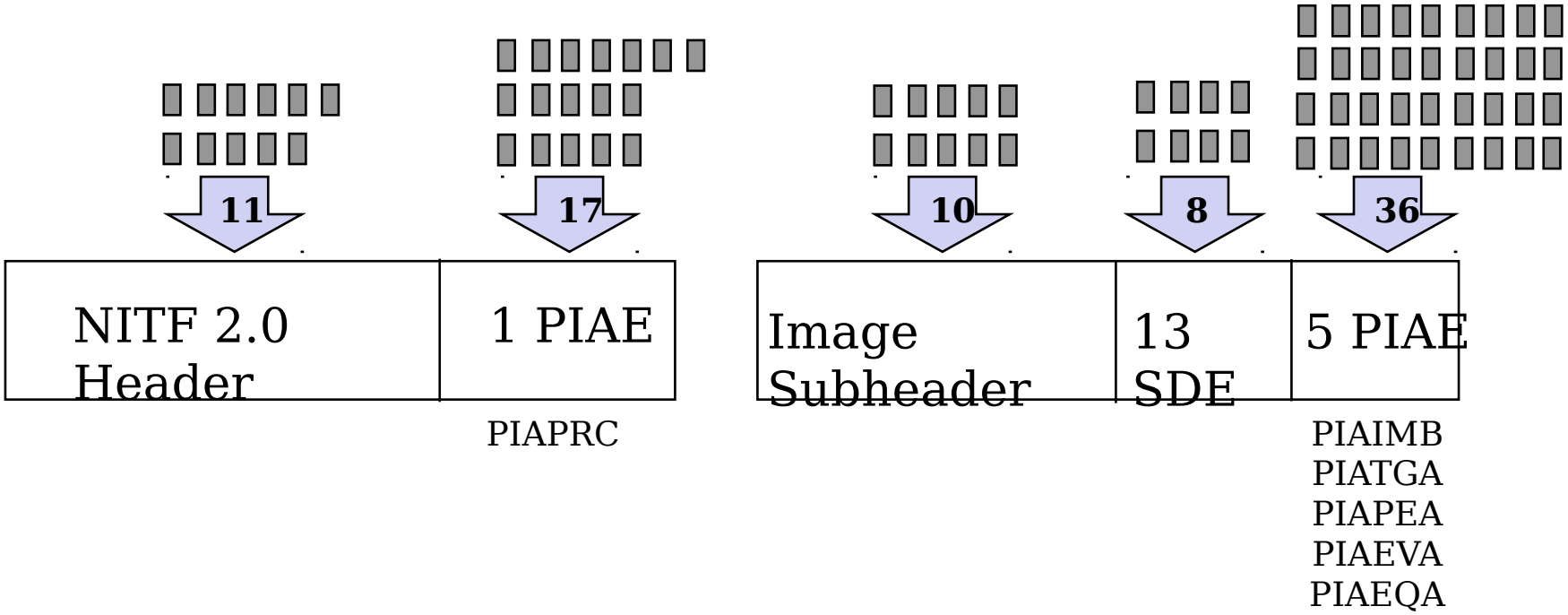
***Physical vs. logical layout of data**

CONFIGURATION MANAGEMENT

- All Controlled Extensions (CEs) are managed by the NTB, to include: name, content, version numbers, and dates. Specifications are available to users.
- Registered Extensions (REs) are managed by name only. Developers must provide to the NTB a rationale for using a Registered Tag instead of a Control Tag. Name value registrations expire in two years.
- DES/RES, also managed by the NTB, used for more stand alone type data and/or for overflow data areas.

PIAEs

Mapping of Archiving Elements of NITF



NITFS TAGGED RECORD EXTENSIONS

- RPF - NIMA Raster Product Format Files (CIB/CADRG)
  - RPFDES, RPFHDR, RPFIMG
- DPPDB - Digital Point Positioning Data
  - IMASDA, IMRFCA, IMCBDA, MASDIR, MSDIRA, OIMCBD, OIMRFC, OIMSD, PPRSDA, PPSD, PRADAA, PRADRA, PROADA, PSD, PROADR, PSUPDA, PTPRAA, RFGRDR, RGRDRA, SEGSPA, SIMCBD, SIMSD, SIMRFC, SSIDD, SISDDA, SSDPDA
- PIAE - Profile for Imagery Archives Extensions
  - PIAEVA, PIAEQA, PIAIMB, PIAIMC, PIAPEA, PIAPEB, PIAPRC, PIAPRD, PIATGA, PIATGB

NITFS TAGGED RECORD EXTENSIONS (CONT'D)

- Geospatial - Tags to support a common geospatial format (DIGEST)
  - ACCHZ, ACCPO, ACCVT, GEOPS, GEOLO, GRDPS, MAPLO, REGPT, SNSPS, SOURC
- Airborne SDE - Support Data Extensions for visible, IR and SAR Airborne systems
  - ACFT, AIMID, BANDS, BLOCK, EXOPT, EXPLT, MENSR, MPDRS, MSTGT, MTIRP, PATCH, RPC00, SECTG, SENSR, STREO
- Commercial SDE - Support Data Extensions for Commercial Products
  - STDIDC, STREOB, USE00A, RPC00B

NITFS TAGGED RECORD EXTENSIONS (CONT'D)

- Complex Imagery
  - CMETAA
- Pre and Post Processing - 12-bit JPEG
  - IOMAPA
- ECC
  - NHECCA, NIECCA
- MISCELLANEOUS
  - HISTOA, ICHIPA, ICHIPB, THEDSA

PRODUCTS

- Geospatial
  - DPPDB
  - CIB/CADRG
  - SRTM
  - Gridded Data Set
- Airborne
- Commercial
- Complex (CMETAA)
- Chipping

DPPDB
Digital Point Positioning Data Base

- Consists of a number of stereo Image Models that range between 50 and 60 NM on a side
- Each stereo Image Model is divided into 5-10 segment models
- Each segment model consists of a left and right segment image
- File structure and content of each DPPDB tape conforms to NITF 2.0 using DPPDB Tagged Record Extensions
- Overview image (reduced resolution)
- CADRG map files (NITF format with RPF TREs)

CIB
Controlled Image Base

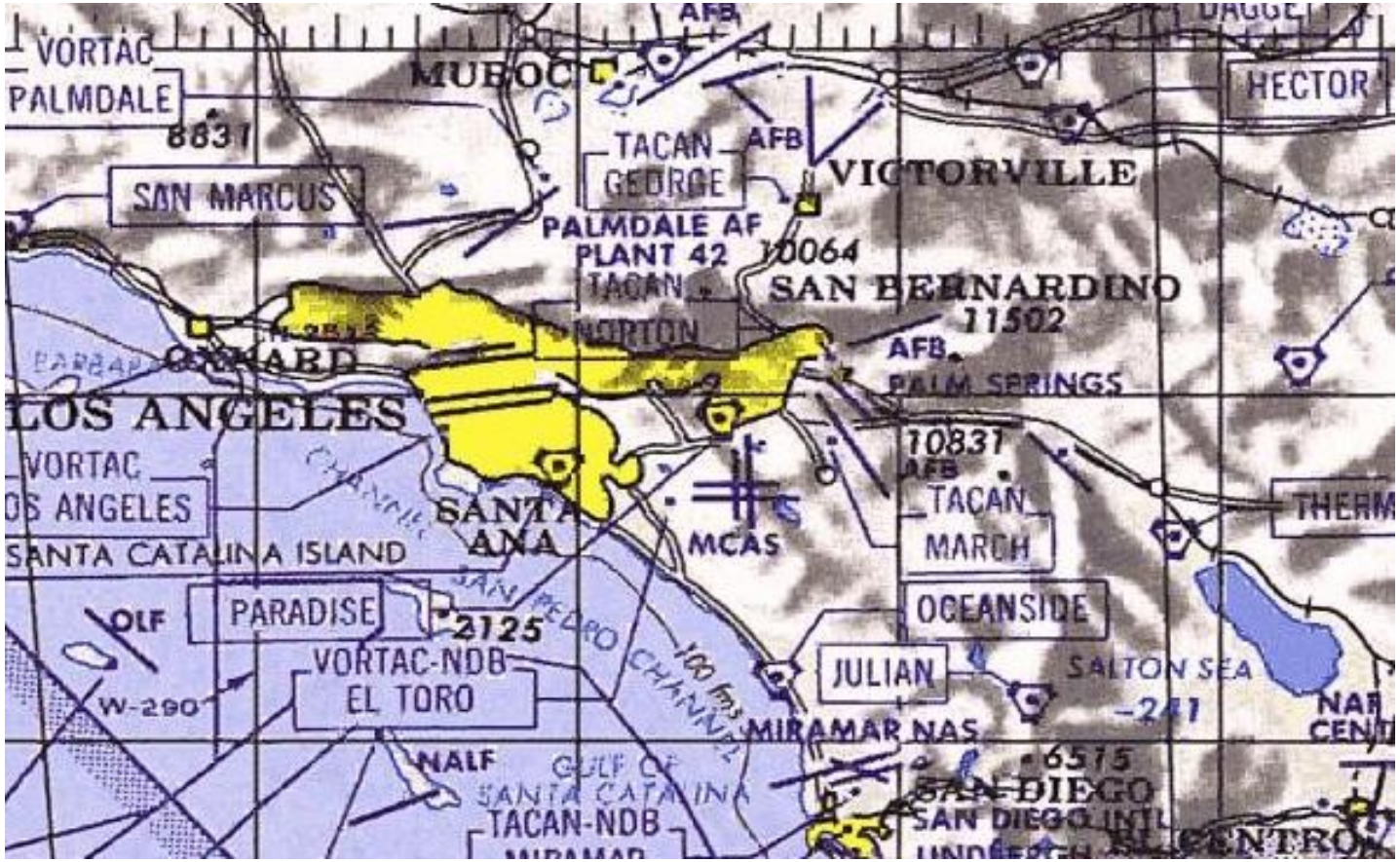
- Dataset of orthophotos made from rectified grayscale aerial images
- CIB supports:
  - weapons
  - C^3I Theater Battle Management
  - Mission Planning
  - Digital Moving Map Systems
  - Terrain analysis and Intelligence Systems
- CIB files are formatted within a NITF file

SAMPLE

CADRG
Compressed ARC Digitized Raster Graphic

- Computer-readable Digital Maps and Charts
- CADRG supports:
  - weapons
  - C3I Theater Battle Management
  - Mission Planning
  - Digital Moving Map Systems
- CADRG is derived directly from ADRG
- CADRG files are formatted within an NITF file

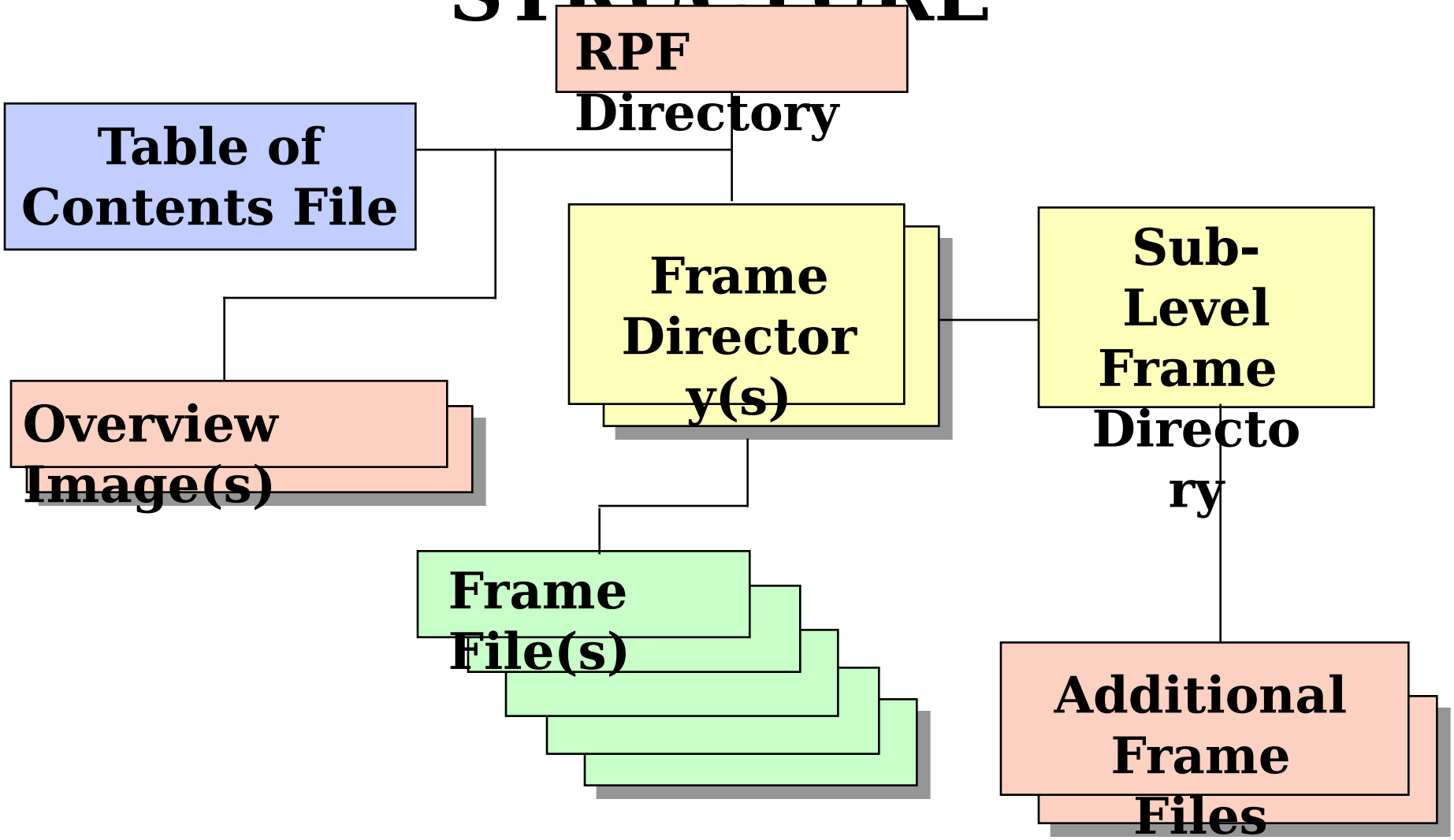
SAMPLE CADRG



RPF FILE STRUCTURE AND COMPONENTS

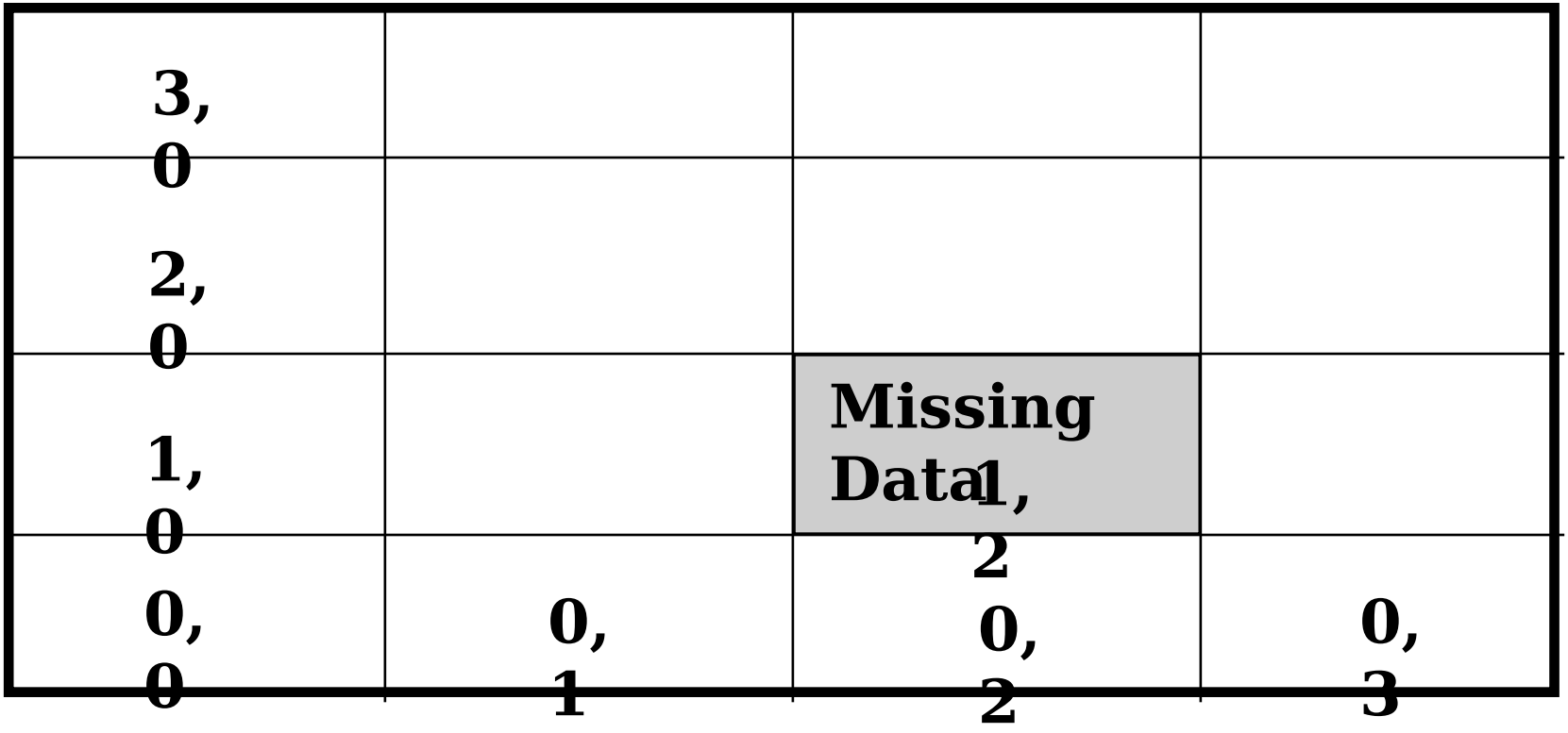
- Multi-file Structure
- TOC and Frame File Contents
- RPF and NITF
- Virtual Matrix

RPF MULTIFILE STRUCTURE



VIRTUAL MATRIX

- Both functions are accomplished via a virtual matrix of Frame Files



VIRTUAL MATRIX EXAMPLE

SRTM PRODUCTS

- Digital Terrain Elevation Data
  - DTED Level 2 format
- Terrain Height Error Data (THED)
  - NITF2.1 format with GeoSDEs
- Orthorectified Image Mosaic
  - Ascending
  - Descending
  - NITF2.1 format with GeoSDEs
- Seam-Hole Composite Map
  - Color-coded Raster showing:
    - Seams of the mosaic
    - Holes showing void data areas
  - NITF2.l format with transparent pixel mask

GRIDDED DATA SETS

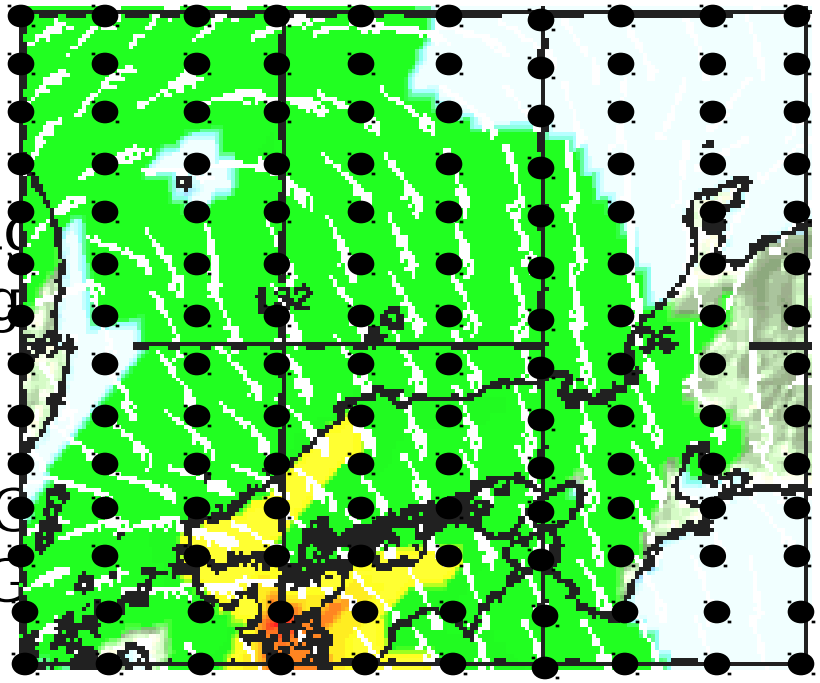
- Types
  - Location Grids
  - Digital Terrain Elevation Models
  - Multiple Layer Data Cubes
    - Climatology-Layered Information
    - Climatology-Time-based Models
- Structure and Placement
  - Uniform-Single Image Segment with multiple bands
  - Not uniform-multiple image segments
- Prominent Groups of Extensions

WHAT IS A GRIDDED DATA SET

- Typically
  - multi-dimensional
  - multi-variable
  - well ordered
- Often
  - "reference" data sets
  - output of models
    - gigabytes
    - may be managed as multiple files

Source:
http://ferret.wrc.noaa.gov/slides

LOCATION GRIDS



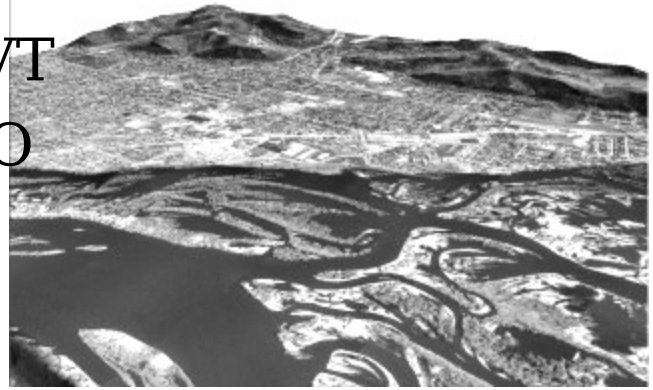
- Two Bands
  - Band X: Longitude or Easting
  - Band Y: Latitude or Northing
- Single Image Segment
  - IREP = LOCG
  - Band X ISUBCAT: CGX or GG
  - Band Y ISUBCAT: CGY or GG
- Regularly spaced intervals
- Grid Description
  - Origin and Ground Spacing described using the DIGEST GeoSDE GRDPS.
  - Data Density is described for rows and columns.
  - Origin for the location grid is also described.

DIGITAL TERRAIN ELEVATION MODELS

- Single Band
  - Band X: Elevation values
- Regularly spaced horizontal intervals
- Single Image Segment
  - IREP = NODISPLY
  - ICAT = DTEM
  - Band X ISUBCAT: denotes unit of measure
- Associated SDEs
  - Accuracy: ACCPO; ACCHZ; ACCVT
  - Location: GEOPS; GEOLO/MAPLO
  - Source:SOURC; SNSPS
- Examples:
  - DTED, DEM

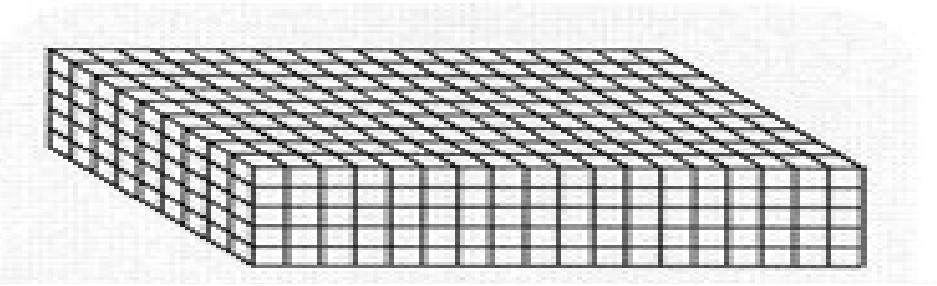
- Output Products:
  - Contour Maps
  - Image Drape

Sample Image Drape



MULTI-VARIABLE MATRICES

- Matrix Description: 3 indexes I, J and K.
- Example: Climatology Data Cube [15-20 Layers]
- Assumption: regularly spaced in all directions [I, J and K]
    - Single Image segment
    - IREP = NODISPLY
    - ICAT = MATR
    - ISUBCAT = ?
    - Associated SDEs:
        - Accuracy: ACCPO; ACCHZ; ACCVT
        - Location: GEOPS; GEOLO/MAPLO
        - Source: SOURC; SNSPS



AIRBORNE PRODUCTS

- Airborne, to include UAV Collectors
- Process Under Development
- VIS, IR, SAR
- Multispectral/Hyperspectral
- Support Data Extensions

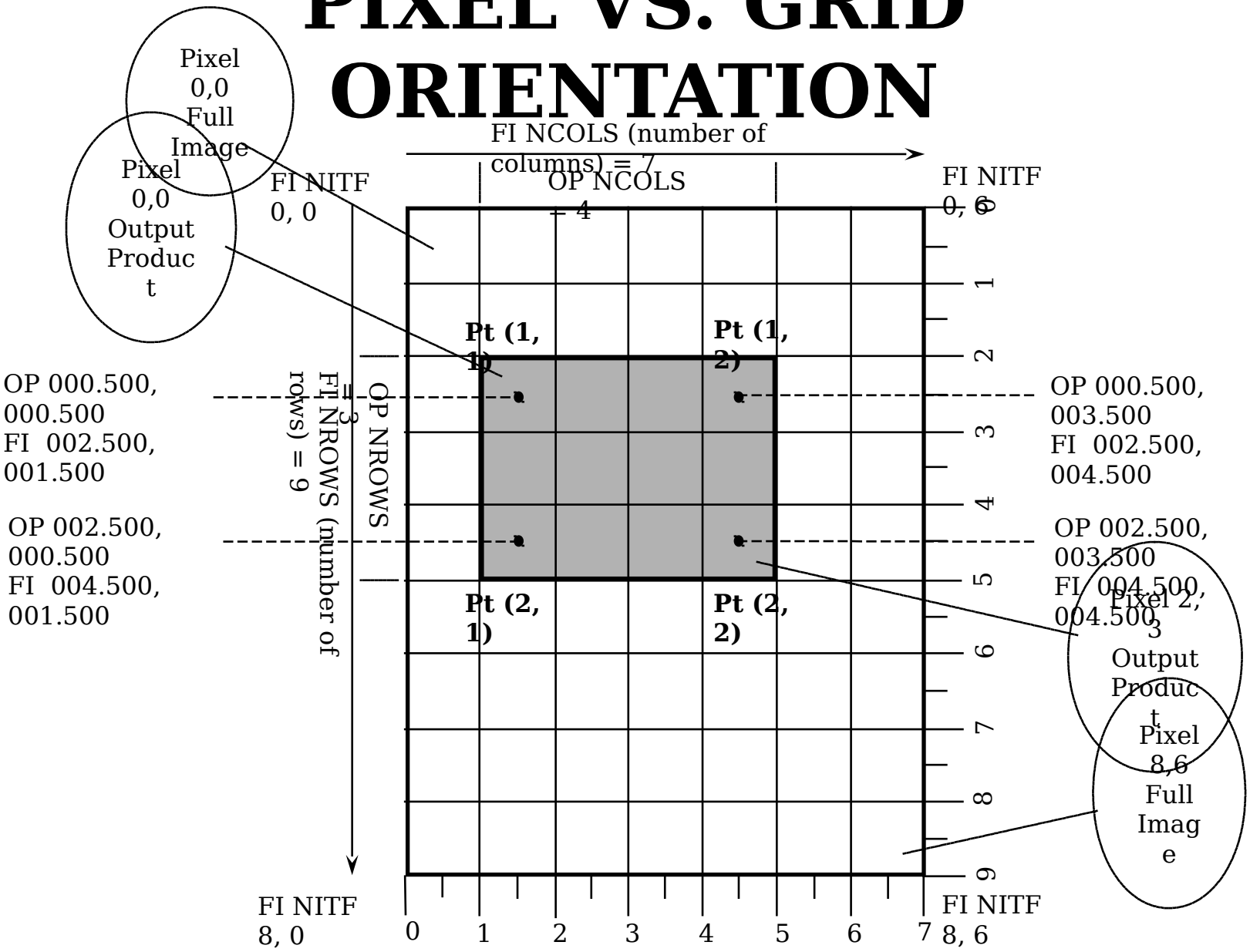
COMMERCIAL PRODUCTS

- Space Imaging
  - Output products available in:
    - NITF 2.0
- Digital Globe
  - Output products available in:
    - NITF 2.0
    - NITF 2.1

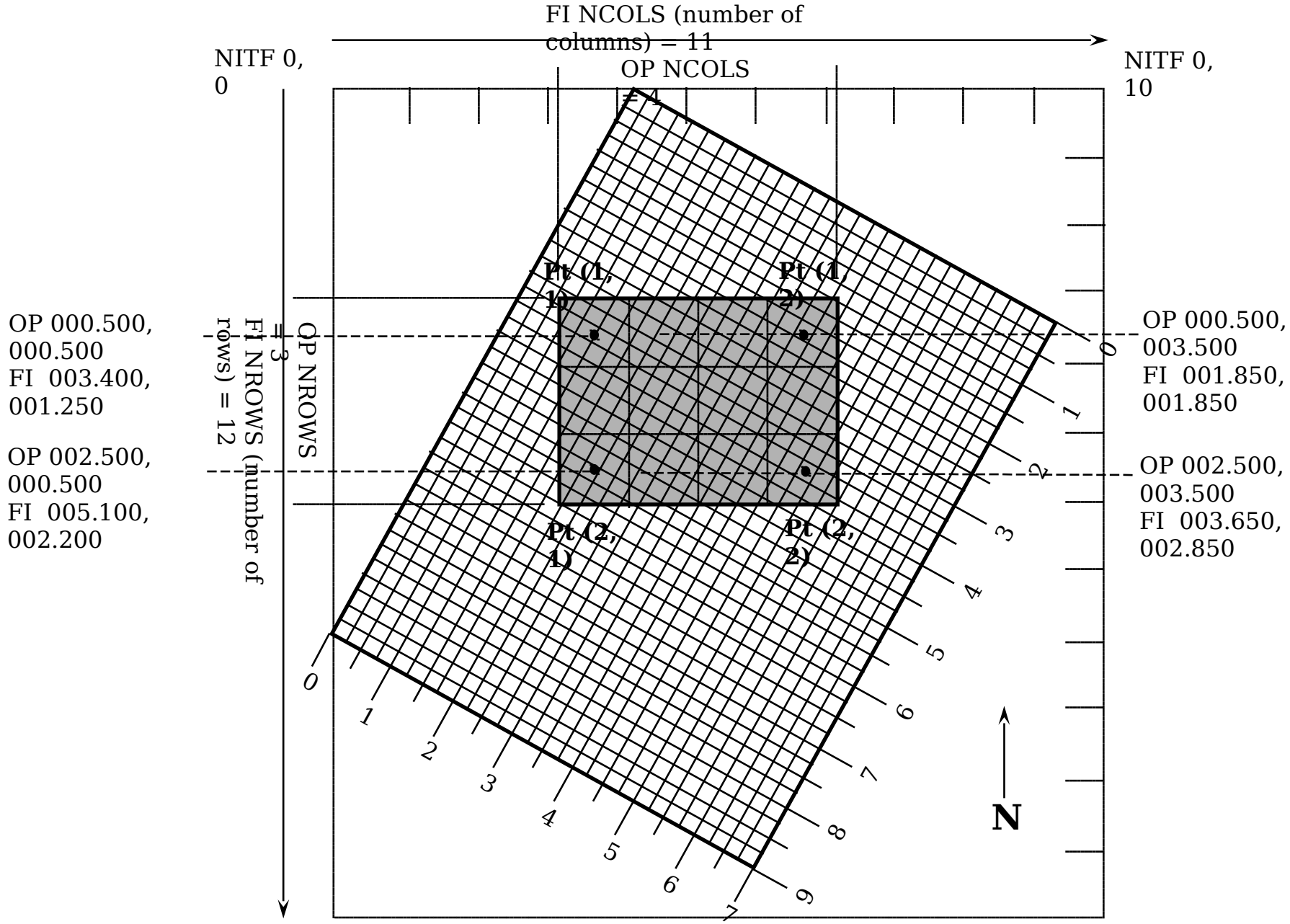
CHIPPED OUTPUT PRODUCTS

- Chip = Image “Sub-Product”
- Support Data Extension (SDE) “Coverage”
- FAF Boundaries
- Chipping on Tagged Record Extensions (TRE)
  - ICHIPB
  - I2MAPD
- Examples

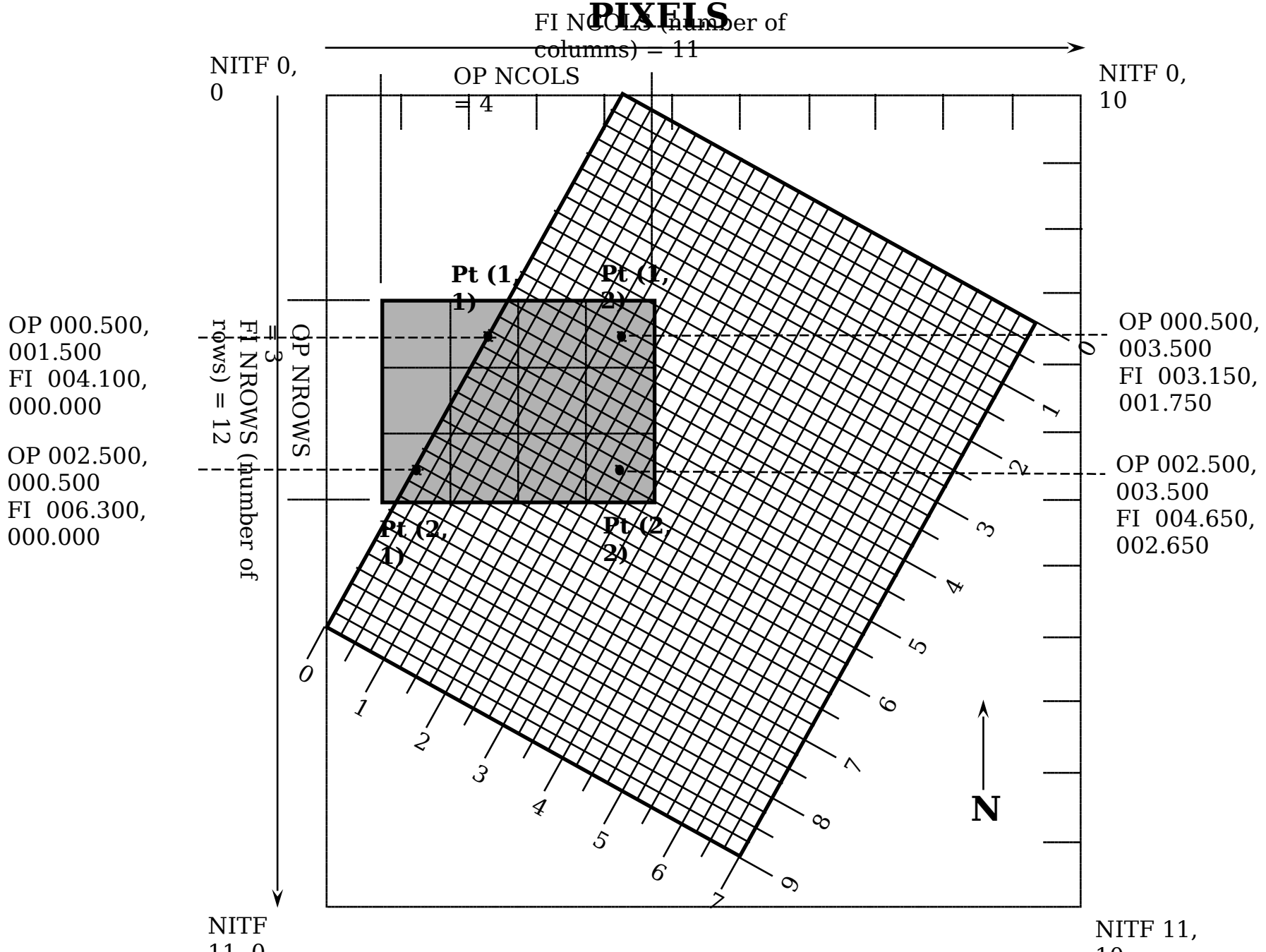
PIXEL VS. GRID ORIENTATION



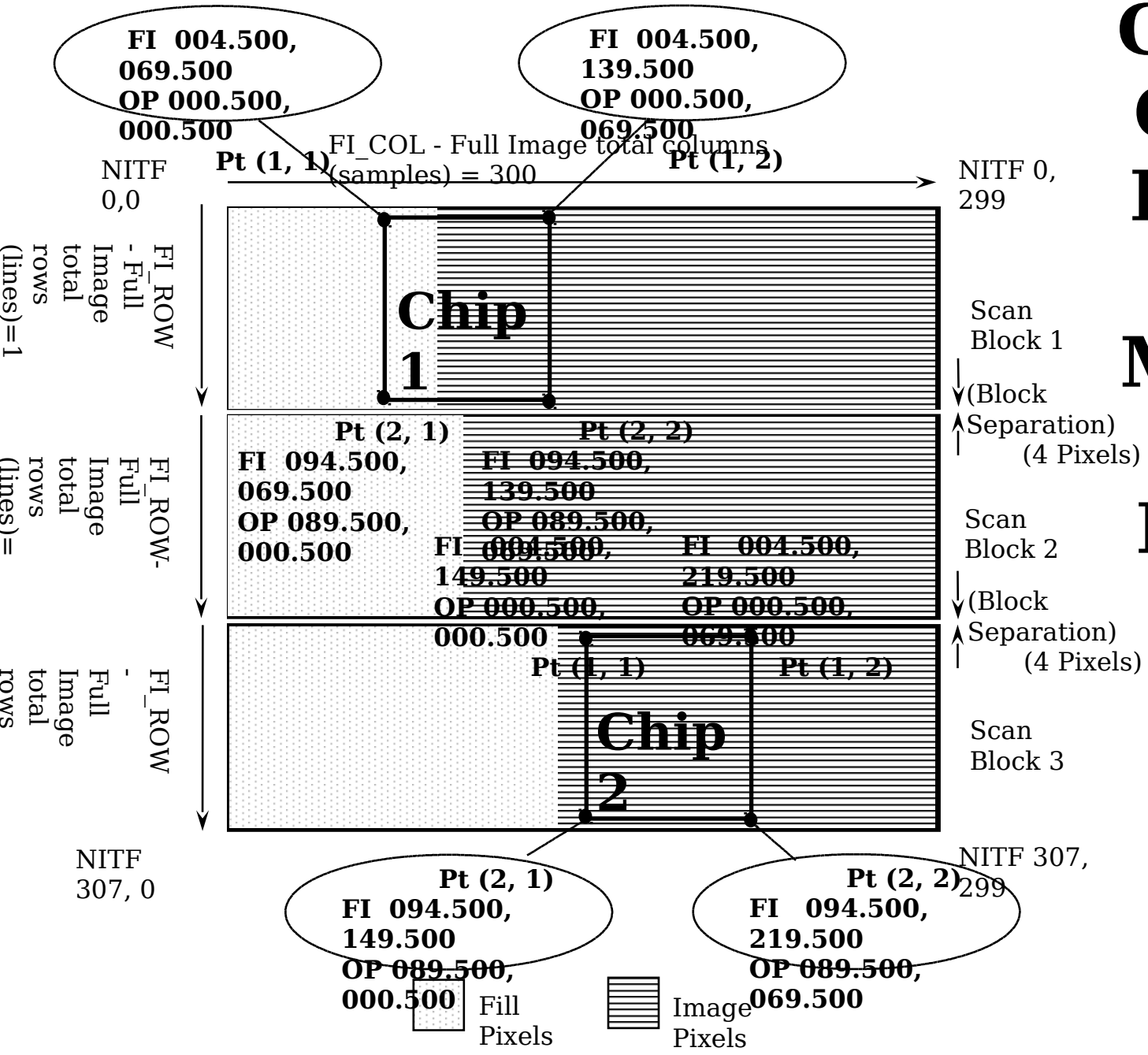
PIXEL VS. GRID ORIENTATION - ROTATION



PIXEL VS. GRID ORIENTATION - ROTATION W/ “INSIGNIFICANT” PIXELS



CHIPPED OUTPUT PRODUCT - MULTIPLE SCAN BLOCKS



WRAP-UP

- **Enhancements in NITF 2.1**
- **Change Summary NITFS 2.0 to NITFS 2.1**
- **Internationalization**
- **The BIIF Relationship**
- **NITF Test Services**

ENHANCEMENTS IN NITF 2.1

NITF 2.1

* Adds New Features Based On Requirements Coming From Field Use
* Is the US Documentation of NATO STANAG 4545
* Represents What Will Eventually Be A Profile of BIIF

MAIN ENHANCEMENTS:

* Year 2000 Compatible Data Structure
* Modified Security Fields to Align With New Exec Order
* Rectangular Block Size
* Alternative Textual Character Sets For International use
* Increases Flexibility of Product Configuration
* Expanded CGM
* Graphic Bounding Rectangles
* Multispectral
* Hyperspectral
* Real Data Types

CHANGE SUMMARY NITFS 2.0 TO 2.1

	NITF 2.0	NITF 2.1
C-Levels	01-06 & 99	03, 05-07, 09
STYPE	Unused	BF01
Date & Time	Year, ZULU	Added Y2K (Century)
Security Fields	Old policy	New policy
Background Color Required	Optional	
Block Shape/SIZE Rectangular, variable	Square, 32 x 32 To 1024 x 1024	
Block/Pixel Masks Required	Optional	
JPEG 12-bit (Decompression)	Optional	Required
VQ (Decompression)	Optional	Required
Geographic Info Robust	Minimal	

INTERNATIONALIZATION OF THE FORMAT

- International Standardization Organization (ISO) Effort
- International Standard 12087-5, Basic Image Interchange Format (BIIF)
  - Approved as an IS, Feb. 1998, published 1 Dec 98
- ISO Registration Authority
  - Profiles of BIIF
  - Profiles of CGM
  - Profiles of JPEG 2000
- NATO STANAG 4545 NSIF
  - Ratified, promulgation date of 2 December 1998

THE BIIF RELATIONSHIP

*BIIF
Format (ISO/IEC 12087-5)

Graphics (Profile of ISO/IEC 8632)

Bandwidth Compression
JPEG (Profile of ISO/IEC 10918-1)
VQ (ISO/IEC 12087-5 Annex B)
Bi-Level (ITU-T RECMN T.4)
ISO Profile of JPEG 2000
Audio (Can be defined by Profile)
Video (Can be defined by Profile)

*NITF & NSIF
Format (NITF: MIL-STD-2500B)
(NSIF: STANAG 4545)
Graphics (MIL-STD-2301)

Bandwidth Compression
JPEG (MIL-STD-198A)
VQ (MIL-STD-199)
Bi-Level (MIL-STD-196)
ISO Profile of JPEG 2000
Audio (undefined)
Video (undefined)
Geospatial SDE (DIGEST)

NITF TEST SERVICES

- Sample NITF 2.1, NITF 2.0 & NITF 1.1 Files
  Call (520) 538-5458
  DSN 879-5458
- WWW Access
  http://jitc.fhu.disa.mil/nitf/nitf.htm
- Email: jitcn@fhu.disa.mil
- Phone: (520) 538-5458
  DSN 879-5458

OTHER KEY URLS

- NITFS Technical Board (NTB)
  http:// www.ismc.nga.mil/ntb

- TRE Register/Product Register

  http://jitc.fhu.disa.mil/nitf/nitf.htm